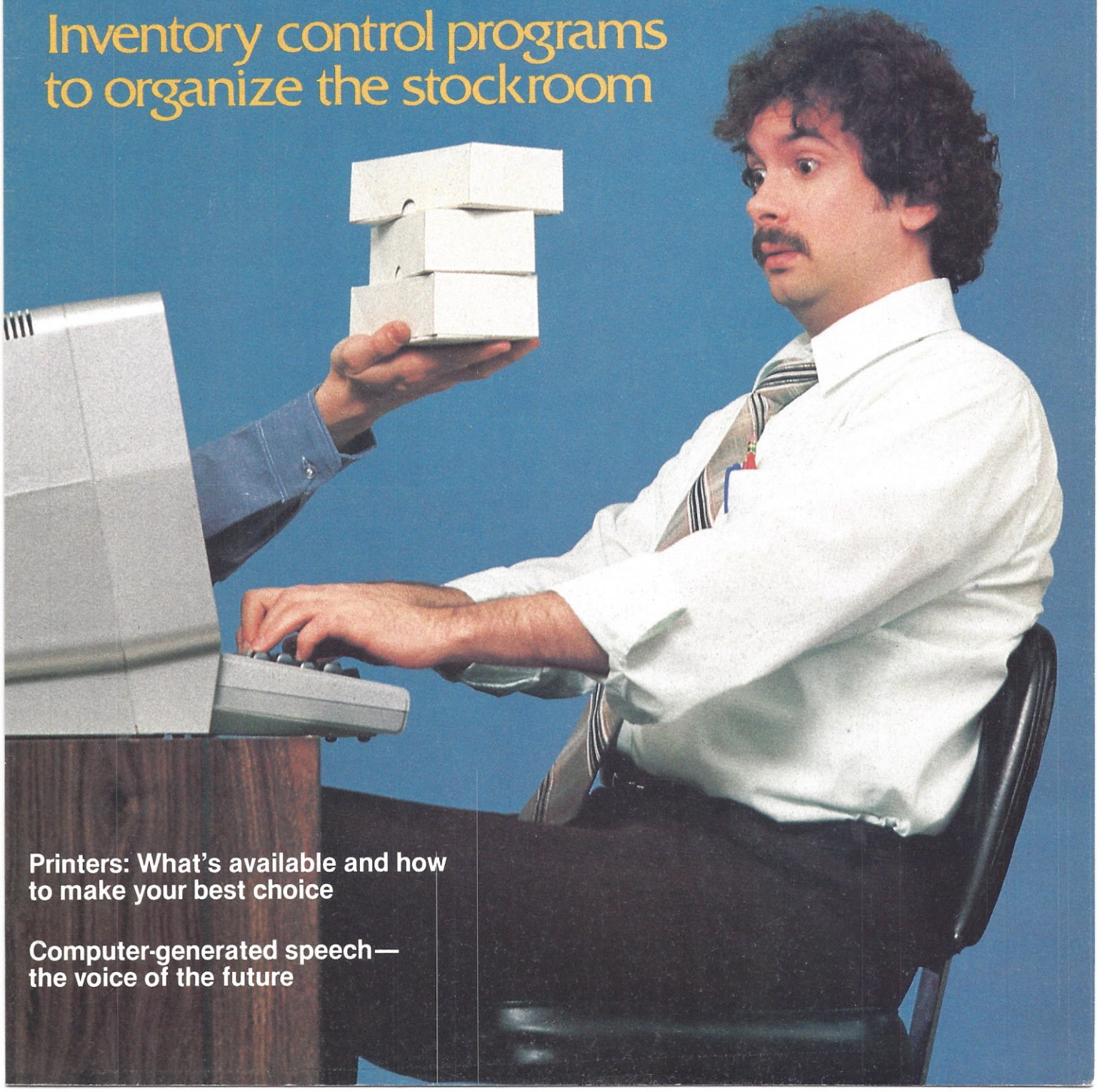
MARCH 1981 $2.00

Personal Computing

FOR YOUR HOME AND BUSINESS

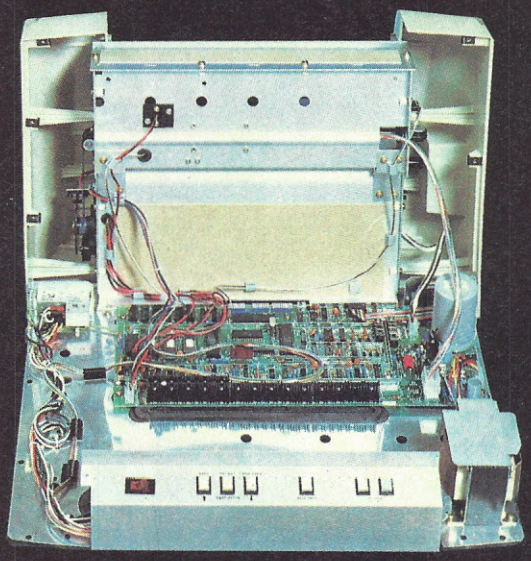
Inventory control programs to organize the stockroom



Printers: What's available and how to make your best choice

Computer-generated speech—the voice of the future

Say Ahh...



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CIRCLE 2

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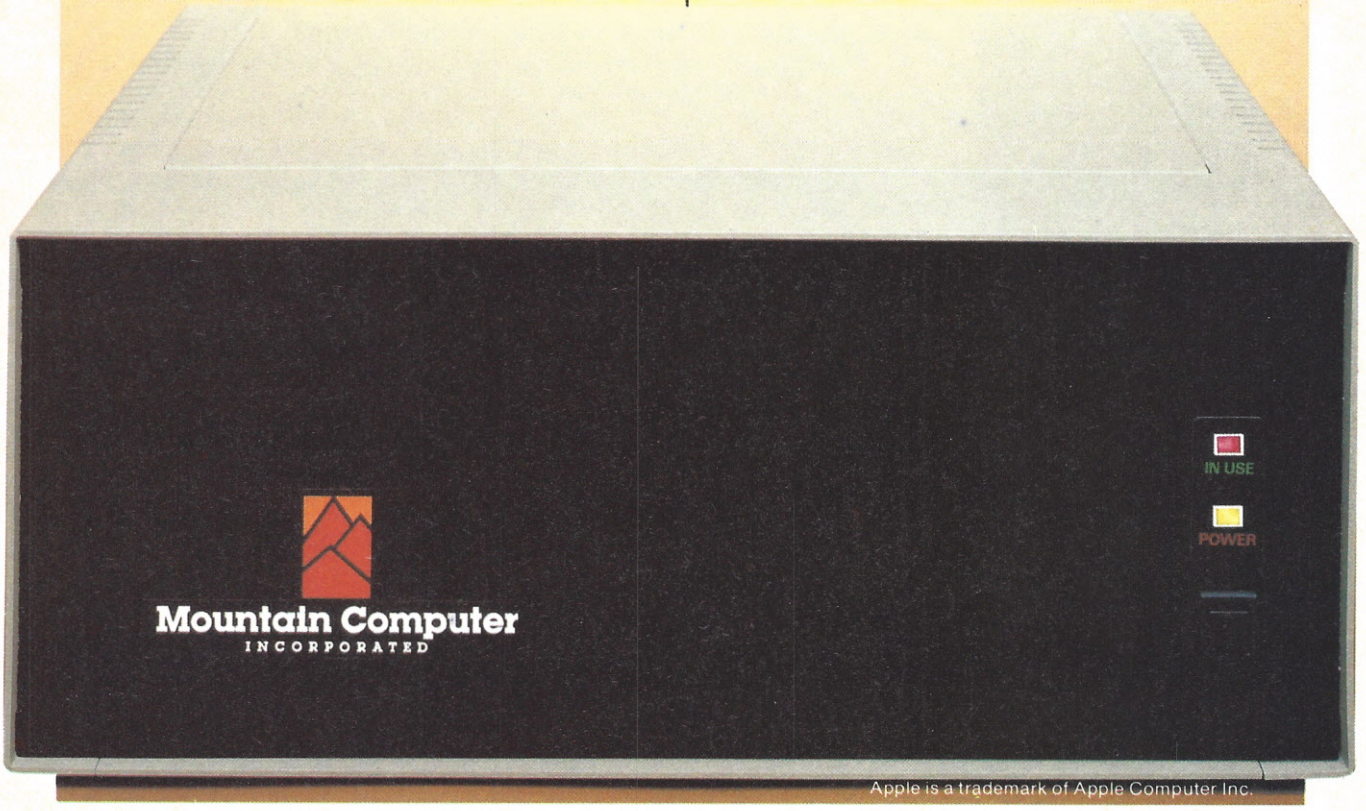

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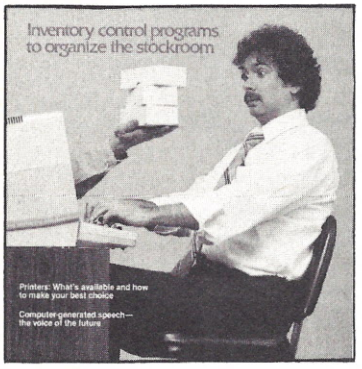
CIRCLE 3

MARCH 1981 VOL. V, NO. 3

Personal Computing

For Your Home and Business

Page 15



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Page 58

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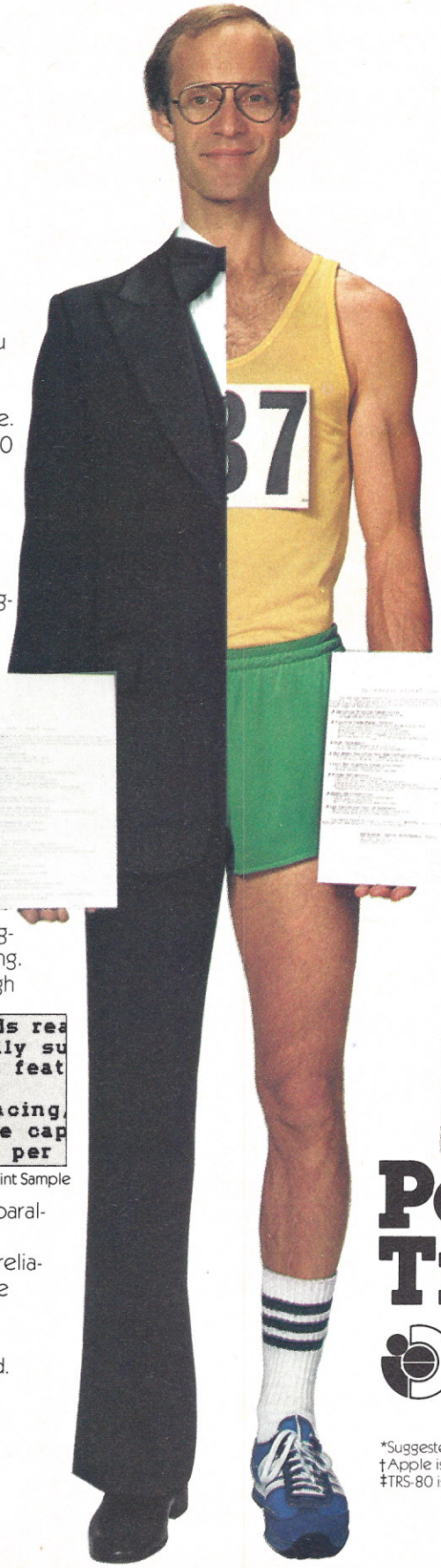
DEPARTMENTS

Introducing quality print at matrix speed. For only $1295.*



Until now, word processing output was a slow, expensive proposition. You could pay thousands for a slow, letter-quality character printer. Or give up print quality for matrix speed and price.

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```
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```

Paper Tiger 460 Print Sample

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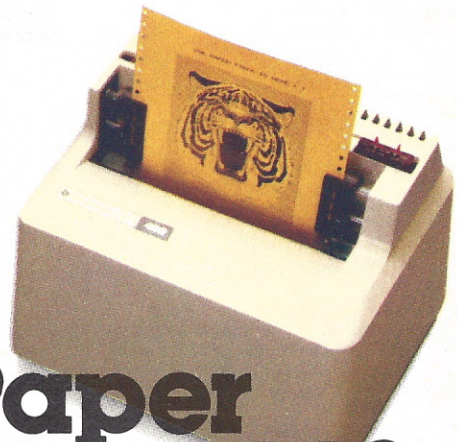

Paper Tiger 460

Integral Data Systems, Inc.

*Suggested single-unit U.S. retail price.
†Apple is a trademark of Apple Computer Inc.
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CIRCLE 4

Personal Computing

MARCH 1981 VOL. V, NO. 3

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PERSONAL COMPUTING (ISSN 0192-5490) is published monthly by Hayden Publishing Company, Inc., 50 Essex St., Rochelle Park, NJ 07662. James S. Mulholland, Jr., President. Printed at The Hart Press, Inc., Long Prairie, MN. Controlled circulation postage paid at Long Prairie, MN. POSTMASTER: Please send form 3579 to PERSONAL COMPUTING, P.O. Box 13916, Philadelphia, PA 19101.

Subscription rates: U.S. 1 year (12 issues) $18; 2 years (24 issues) $33; 3 years (36 issues) $46. Canada & Mexico: add $4/year for surface mail, $8/year for airmail. Other countries: add $8/year for surface mail, $36/year for airmail. **Back issues:** U.S.: $4. All other countries $5.

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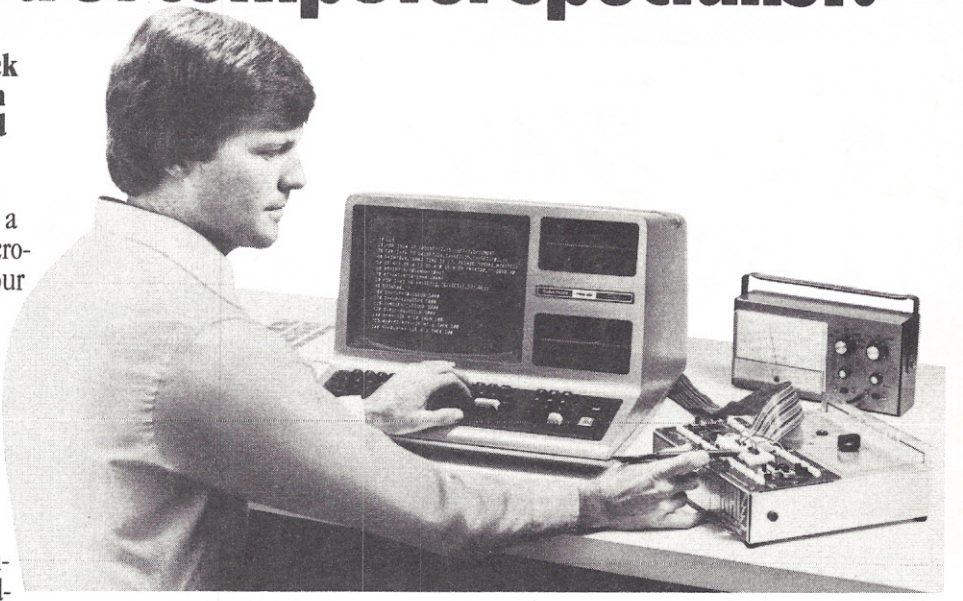

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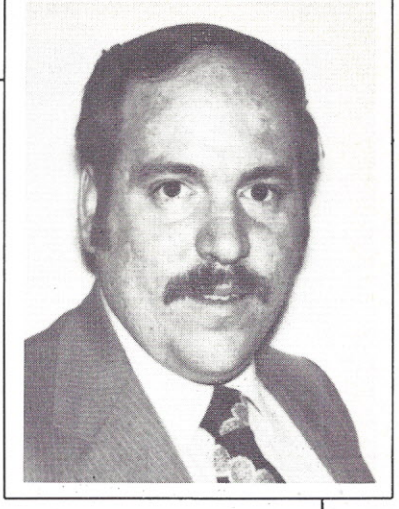
CIRCLE 8

EDITORIAL



With A Little Help From A Friend

The personal computing industry is growing rapidly and occasionally problems that should not arise, do. These problems can take many forms: a printer that doesn't operate properly with a computer; protected software that crashes leaving the user without a backup; software and hardware that won't work together. Most of the time, such situations are easily resolved. In some instances, however, small problems become major crises because of a lack of effective communication between buyer and vendor.

Personal Computing would like to help alleviate such situations in order to make your computer experience more pleasurable, productive and rewarding. To that end we are instituting a new, monthly feature called "Computer Action Line," the purpose of which will be to help solve apparently insurmountable problems.

If you have been unsuccessful at solving a problem with any manufacturer, let us know. Send us photostatic copies of letters, receipts and any other pertinent documentation relating to your situation; we will evaluate the information and try to help if we can. Do not send your original documentation.

Remember that most manufacturers are reasonable and will assist you whenever possible, so use *Computer Action Line* only when all attempts to resolve the problem by yourself have failed. Address all material to: *Computer Action Line;* Personal Computing Magazine; 50 Essex St.; Rochelle Park, NJ 07662. We'll try to give you a helping hand.

Jules H. Gilder
Editor

FEEDBACK

Ready For More

Sirs:

Thank you for the article: "Translating TRS-80 Level II BASIC to TI 99/4 BASIC" in your November, 1980 issue. Since there are no (none, not any) programs currently published in TI BASIC, I'm sure this is appreciated by all TI 99/4 users who, like myself, want to do something besides use the TI modules and are not yet ready to program on their own. Now, if you will just do the same with Apple BASIC . . .

John B. Sewell
Houston, TX

Editor's note: We expect to be seeing some interesting software for the TI 99/4 in the next few months, and we'll certainly inform our readers when it becomes available.

Continued Regression

Dear Sir:

My congratulations to Mikel Aickin for his interesting program: "Regression Analysis," in the January, 1981 issue.

By adding a few lines, the program will be able to calculate the correlation coefficient, a parameter useful for judging how well the correlation fits the data. For example, for the school district problem, (Figure 4 and Table 2), add the following lines:

```
110 DIM R(20)
685 FOR I=1 TO L
687 J=I*(I-1)/2 + 1
689 R(I)=S(J)
691 NEXT I
1012 RS=0
1032 RS=RS+R(I)*S(J)/R(1)
1050 PRINT
1055 PRINT"CORRELATION COEF=";RS
```

R.D. Biggs
Baton Rouge, LA

Dear Editor:

Thank you for publishing the articles on multiple linear regression (by Mike De Santis in January 1980 and by Mikel Aickin in January 1981). Aickin's program is fast, uses relatively little memory, and is more accurate than a program I paid $95 to get. I am grateful for Aickin's lucid introduction to UPDATE and SWEEP.

A few minor errors crept in. The seventh value of D in Table 3 should be 2, and the regression for the swimming pool example should be Y = 2.473 etc. And I believe that in the second paragraph under "UPDATE and SWEEP Algorithms" the sentence should read: "Thus you can get M(k+1) from knowing just M(k) and Y(k+1)."

A person usually wants to know more about a regression than the coefficients, so I modified Aickin's program to calculate the coefficient of determination (R^2), the adjusted R^2, and the F-statistic. The t-statistic for the A-variable in the swimming pool example suggests that the A-variable should be eliminated, and elimination of the A-variable slightly improves the confidence level of the F-statistic.

```
Regression coefficients:
  2: .985005894416
  1: 19.9271867787
R²: .995622471934
Adjusted R²: .994371749629
F: 1592.07598399
F/4: 398.018995998
```

```
Hewlett-Packard HP-85
10 DEFAULT OFF @ OPTION BASE 1 @
    Y2=0 @ INTEGER I, J, K, L, N, P
   T
20 DIM D(12), M(12), R(12), S(78),
   X(12), R$[1]
30 DEF FNL (Q) = Q*(Q-1)/2
40 DISP "NUMBER OF VARIABLES";
50 INPUT L@ FOR I=1 TO L@ M(I)
   ,R(I)=0 @ DISP "TRANSFORM X(
   ";I;") TO LOG (Y/N)";
60 INPUT R$@ IF R$="Y" THEN R(I
   )=1
70 NEXT I @ DISP "NUMBER OF CAS
   ES";
80 INPUT N@ FOR I=1 TO L*(L+1)/
2 @ S(1)=0 @ NEXT I @ FOR I=
1 TO N @ DISP "CASE"; I
90 FOR J=1 TO L @ DISP "X(";J;"
   )";
100 INPUT X(J) @ IF R(J)=1 THEN X
    (J)=LOG (X(J))
110 D(J)=X(J)-M(J) @ M(J)=M(J) + D
    (J)/1 @ IF J=1 THEN Y2=Y2+X(
    1)^2
120 FOR K=1 TO J @ P=FNL (J) +K @
    S(P)=S(P)+D(J)*D(K)*(I-1)/I
    @ NEXT K @ NEXT J @ BEEP
130 NEXT I @ FOR I=2 TO L @ T=I*
    (I+1)/2 @ IF S(T)=0 THEN GOTO
    300
140 FOR J=1 TO L @ IF J=I THEN GOTO
    220
150 IF J < I THEN Q=FNL (I)+J
160 IF J > I THEN Q=FNL(J)+I
170 FOR K=1 TO J @ IF K=1 THEN
    GOTO210
180 P=FNL(J)+K @ IF K < 1 THEN R=F
    NL (I)+K
190 IF K > I THEN R=FNL (K)+I
200 S(P)=S(P)-S(Q)*S(R)/S(T)
210 NEXT K
220 NEXT J
230 FOR J=1 TO I-1 @ P=FNL (I)+J
    @ S(P)=S(P)/S(T) @ NEXT J @
    IF I=L THEN GOTO 250
240 FOR J=I+1 TO L @ P=FNL(J)+I
    @ S(P)=S(P)/S(T) @ NEXT J
250 S(T)=-1/S(T) @ NEXT I @ Z=M(
    1) @ PRINT "Regression coeff
    icients:"
260 FOR I=2 TO L@ J=FNL(I)+1 @
    PRINT I;":";S(J) @ Z=Z-M(I)*
    S(J) @ NEXT I @ PRINT "1:",Z
270 R2=(Y2-S(1)-N*M(1)^2)/(Y2-N*
    M(1)^2) @ PRINT "R²: ";R2
280 PRINT "Adjusted R² : " ;1-(1-R2
    )*N/(N-L)
290 F=(Y2-S(1)-N*M(1)^2)/(L-1)/(
    S(1)/(N-L))@PRINT "F:";F@
    PRINT "F/4:" ; F/4 @ GOTO 310
300 DISP "VARIABLE" ;I; "IS A LINE
    AR COMBINATION OF THOSE
    PRECEDING IT"
310 BEEP @ END
```

One significant relationship that inspires 100% confidence (by the F-test) is that between money and prices for the past 8 quadrennia:

	Implicit Price Deflator (=P)	Adjusted Monetary Base (=M)
9/48	53.79	$37.6 billion
9/52	58.00	40.2
9/56	63.25	42.3
9/60	68.81	43.9
9/64	72.93	52.4
9/68	82.88	65.6
9/72	100.29	84.5
9/76	134.35	117.3
9/80	183.23	164.1

P = 19.92 + .985 * M (notice how close to unity .985 is) and R^2 is .9956. Since 1966 the Federal Reserve has been increasing the monetary base faster than the real gross national product, and for the

last 6 years the quadrennial growth rate has been between 8% and 9% annualized. The (inflated) buck *starts* in the Oval Office, whenever the President sends an unbalanced budget to the Congress.

Linear regression can't solve the inflation problem, but it can help to make it perfectly clear.

Gordon D. Kirchhevel
Chicago, IL

TRS-80/Base 2 Labels

Dear Editor:

After reading the article by Alan Walker in the July 1980 Personal Computing on cassette labels, I decided it would be a good way to get my own tape library in order. However, the program was written for the PET and I own a TRS-80 Level II and a Base 2 Model 800 printer.

Converting the program was both educational and fun. The following program resulted. The main program follows the original very closely. Most of the changes were made to make the Base 2 happy.

```
1 CLEAR 200
8 LPRINT CRH$(27);CHR$106)
10 CLS
200 PRINT "PRESS ANY KEY TO
START"
210 A$=INKEY$:IF A$="" THEN 210
220 CLS
500 FOR I=1 TO 2
505 S$(I)="":P=0
510 PRINT "ENTER A /-/ WHEN COM
PLETED"
520 PRINT "ENTER THE PROGRAMS
ON SIDE";I
525 PRINT "(MAX. 30 CHARACTERS)"
530 PRINT: P=P+1
540 PRINT "PROGRAM #" ;P
550 INPUT A$
560 IF A$="-" THEN 620
570 IF P=1 THEN S$(I)=A$: GOTO 590
580 S$(I)=S$(I)+":" +A$
590 L(I)=LEN (S$(I))
600 IF L(I) > 36 GOTO 700
610 GOTO 530
620 NEXT I
630 GOTO 800
700 '* TOO MANY CHARACTERS*
710 PRINT "THE PROGRAMS YOU
HAVE ENTERED FOR THIS"
720 PRINT "SIDE ARE TOO LONG. YOU
MIGHT TRY USING"
730 PRINT "ABBREVIATIONS FOR
ONE OR MORE OF THEM."
740 PRINT
750 PRINT "PRESS ENTER WHEN
READY TO REDO THEM"
770 A$=INKEY$: IF A$=" " THEN 770
ELSE 10
800 '*SET UP STRINGS FOR PRINT
OUT*
810 C$(1)=S$(1) : C$(2)=S$(2)
820 FOR J=1 TO 2
830 FOR I=1 TO 37-L(J)
840 C$(J)=C$(J)+ " "
850 NEXT I
860 N$(J)=RIGHT $(STR$(J),1)
870 NEXT J
1000 '*SELECT PRINTOUT*
1010 CLS
1020 PRINT "1-PRINT CASSETTE BOX
LABEL"
1030 PRINT :PRINT "2-PRINT CAS
SETTE TAPE LABELS"
1040 PRINT :PRINT "3-PRINT BOTH"
1050 PRINT :PRINT "WHICH ?"
1060 A$=INKEY$: IF A$="" THEN 1060
1070 IF A$ < "1" OR A$ > "3" THEN
     1060
1080 A=VAL (A$)
1090 ON A GOTO 1100, 1200, 1300
1100 GOSUB 2000: GOTO 6000
1200 GOSUB 3000: GOTO 6000
1300 GOSUB 2000: GOSUB 3000: GOTO
     6000
2000 '*PRINT CASSETTE BOX LABEL*
2020 LPRINT ".";
2030 LPRINT STRING$(39,45);
2040 LPRINT "."
2050 FOR I=1 TO 4
2060 LPRINT "!"; TAB(40);"!"
2070 NEXT I
2080 LPRINT "!";
2090 LPRINT STRING$(39,45);
2100 LPRINT "!"
2110 LPRINT "!" +N$(1)+" "+C$
(1);TAB(40);"!"
2120 LPRINT "!"+N$(2)+" "+C$ (2);
TAB(40);"!"
2130 LPRINT "!";
2140 LPRINT STRING$(39,45);
2150 LPRINT "!"
2160 LPRINT "!";TAB(40);"!"
2170 LPRINT "!";CHR$(14)"SIDE
1:"CHR$(14);
2180 LPRINT TAB (35);"!"
2190 LPRINT "!";TAB(40);"!"
2200 LPRINT "!"+C$(1);TAB(40);"!"
2210 LPRINT "!";TAB(40);"!"
2220 LPRINT "!";TAB(40);"!"
2230 LPRINT "!";CHR$(14)"SIDE
2:"CHR$(14);
2240 LPRINT TAB (35)"!"
2250 LPRINT "!";TAB(40);"!"
2260 LPRINT "!"+C$(2);TAB(40);"!"
2270 FOR I=1 TO 5
2280 LPRINT "!";TAB(40);"!"
2290 NEXT I
2300 LPRINT "!";
2310 LPRINT STRING$(39,95);
2320 LPRINT "!"
2340 RETURN
3000 '*TAPE LABEL*
3010 FOR J=1 TO 2:BL$=" "
3020 LPRINT ".";
3030 LPRINT STRINGS(34,45);
3040 LPRINT "."
3050 LPRINT "!";CHR$(14)"SIDE";J;
CHR$(14);TAB (30);"!"
3070 L=34-L(J)
3080 L1=INT(L/2)
3090 FOR I=1 TO L1
3100 BL$=BL$+" ":NEXT I
3110 LPRINT "!";
3120 LPRINT BL$;S$(J);
3130 FOR I=1 TO L-L1:LPRINT"
";:NEXT I
3140 LPRINT "!"
3150 LPRINT "!"
3170 LPRINT STRING$(34,42);
3180 LPRINT "!"
3190 LPRINT "!";
3200 LPRINT TAB(7)STRING$(22,95);
TAB(35)"!"
3210 FOR I=1 TO 2
3220 LPRINT "!";TAB(6)"!";TAB(29)
"!";TAB(35)"!"
3230 NEXT I
3240 LPRINT "!"TAB(6)"!";TAB(7) STR
ING$(22,95);"!"TAB(35)"!"
3250 LPRINT "!";TAB(35)"!"
3260 LPRINT "!";CHR$(14);TAB(5)
"JACK CURLEY";CHR$(14);TAB(23)"!"
3280 LPRINT "!";STRING$(34,95);"!"
3400 NEXT J
3420 RETURN
6000 END
```

Lines 2170, 2230, 3050 and 3260-CHR$(14) is the Base 2 control code to turn the elongated character mode on and off. The rest of the changes were in the box and label print subroutines to run the Base 2 printer instead of the Commodore.

John Curley
Cedar Rapids, IA

Data Base Bugs

Dear Editors:

Your informative article, "How to Choose Data Base Management Programs," made a good start toward explaining a vital and difficult subject, and I wish to thank the authors for their compliments on our DB Master program.

However, your article contained a few ambiguities and misconceptions which I would like to clear up.

First of all, although most of DB Master is written in BASIC, the program's most critical elements are written in 16K (that's right—over 16,000 bytes) of machine language code. This includes our modified DOS (about 4K, including a "chain" routine which runs five times as fast as Apple's) and the entire ISAM file system (about 12K).

And speaking of ISAM, DB Master's file system is far more sophisticated than the one described in

the article. Rather than storing pointers to each individual record (which wastes a tremendous amount of storage space) DB Master maintains an index which includes only the highest key value in each data block. When performing a primary key search, it is simple matter to determine which data block contains the desired record. That block is then loaded from a disk and searched in RAM for the appropriate data. As mentioned in the article, this process takes less than three seconds. Our *secondary* key searches, which do require one-to-one, key-to-record pointers, take roughly twice as long.

By adding a second level of ISAM indexing, which we have done with DB Master, additional diskettes (or volumes) of data may be indexed at a cost of less than 50 bytes each.

The first index, which is always in RAM, holds the highest key for each volume, and each volume contains an index to the data blocks included on that diskette.

The article also discussed another program's "packing technique that . . . stores multiple records per diskette sector instead of the more commonly used method of one record per sector." Programs which cannot store multiple records per sector are as obsolete as entering data from front panel switches (an Apple diskette only has 516 sectors.)

For state-of-the-art data packing, see the DB Master User Manual, page 18: " . . . the system will automatically store 3 to 255 consecutive recurrences of any single character in just two or three bytes. This includes recurrences that cross multiple field boundaries, so that a number of consecutive empty fields will be packed into just two bytes on the disk."

Thank you once again.

Barney Stone, Co-author
Stoneware
Microcomputer Products
1930 Fourth Street San Rafael,
CA 94901

Editor's note: We'd also like to mention that two illustrations used in the article on pages 24 and 26 were provided courtesy of Stoneware.

Same Problem, Two Solutions

Dear Editors:

The article on *Goblin*, the small system fantasy game, by Mr. Robert T. Nicholson which appeared in your December 1980 issue, was most enjoyable. But it appears that the program contains a rather severe logic error. Permit me to explain my understanding of the problem.

The string variable DO$ defines the walls of a 36 square matrix which is used as the dungeon. Each character of this string represents the status of one wall of one room

(W=WALL, C=CLOSED DOOR, L=LOCKED DOOR and Ø=OPEN DOOR).

The problem lies in the means of accessing this character string.

The error exists in lines 4040-4060. A careful analysis seems to demonstrate that this algorithm will only access the first half of the DO$ string. Thus, the dungeon matrix will always be a symmetrical matrix, with the axis of symmetry located on the main diagonal, that is, Rooms 1, 8, 15, 22, 29 and 36.

For the casual player, the program will work fine until they are in a room on this main diagonal. In this case, for a room with each wall having a door, for example, closing the North door will also close the West door, and closing the South door will also close the East door. The effect will exist for every room in the dungeon but is directly observable only in rooms on this main diagonal. Indeed, closing any door in any room will close the mirrored door in the mirrored room across the diagonal.

In essence, the whole latter half of the DO$ string is not used. My correction for the problem is as follows:

```
4040 T1=INT(SO/6.1)+1
4045 K=6
4050 IF K >=SO THEN 4065
4055 K=K+6
4060 GOTO 4050
4065 T2=(5-(K-SO)+6
4066 IF 12 > 2 THEN I1=42=
T1=T2
4067 IF 12=3 THEN I1=I1+6
4070 T$=DO$(I1,I1)
```

While I am at it, I might as well point out that line 650 is redundant, L(8) having already been defined in line 570.

In any case, the game is quite enjoyable and I thank Mr. Nicholson for his effort in its creation. It offers considerable potential to other programmers who might wish to build on this as a start toward a dungeon game of their own.

Roy S. Reichert
Warren, NJ

Dear Editors:

Robert Nicholson's *Goblin* game in the December, 1980 issue is excellent. I would not be surprised to see it achieve general acceptance. I was inspired to put *Goblin* up on the computer right away, and did so even before the December issue date.

All is not roses, however. *Goblin*, as published, has a significant bug. Basically, the FNW function fails to keep the North-South and East-West walls separate. The second half of the DO$ string is accidentally ignored. Whenever you open a door, another door opens, sometimes in the same room. The statements to correct this are:

```
4050 IF I2=3 THEN I1=
(SO-T1*6)*6+T1+43
4060 IF I2=4 THEN I1=
(SO-T1*6)*6+T1+37
```

David W. Hamaker
San Francisco, CA

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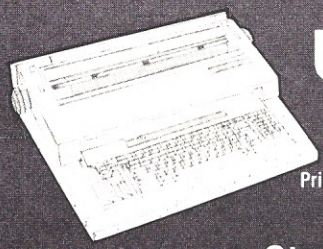

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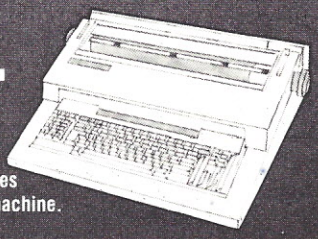

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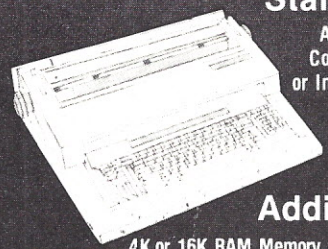

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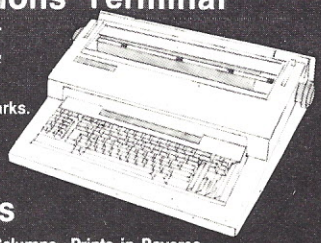

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CIRCLE 11

An Apple goes to China

BY JAMES S. COAN

The summer of 1980 brought the realization of a dream that my family has had for many years—a visit to China. My wife, whose mother is Chinese and whose father was an American from Illinois, grew up in China and came to the United States in 1949. With the growing normalization of relations between the United States and the People's Republic of China it has become easier for people like us to travel to China. Thus, with passports in hand, we began planning to spend the months of July and August, 1980, there visiting relatives and friends spread from Guangzhou (Canton) to Bejing (Peking).

Workers at a welding factory in Guangzhou gather to see the Apple II computer.

The Apple II Plus is set up at Chekang Medical College in Hangzhou, China.

Enter Apple

It seemed appropriate for me to pursue my interest in computers, especially since a number of the persons we would be visiting are associated with schools, colleges and research institutes. By March several invitations to give talks had already arrived. Ideally, I wanted to present an educational institution with a microcomputer. My call to Apple Computer, Inc. was returned by Stephen C. Shank, Far East business manager. Shank said the company might be interested in supplying an Apple with disk for just such a presentation. Apple had already arranged to participate in the first commercially-sponsored exhibit of American electronic equipment to be presented in the People's Republic of China August 15-24, 1980, at the Guangzhou Trade Center Fair Site. A slight adjustment in my family plans would accommodate my attendence there too.

Thus encouraged, I made inquiries about the potential difficulties associated with carrying a computer through customs. It seems that a letter from an institution in China stating that it would be happy to receive the article should make it possible to avoid paying duty. My wife, who has a cousin at Chekang (Zhejiang) Medical College in Hangzhou (Hangchow), put me in touch with the president of the college. The institution would appreciate having a microcomputer presented to it.

By this time we had confirmed flight reservations to Hong Kong and the pieces were beginning to fit into place. A call to Stephen Shank confirmed that an Apple computer with disk would indeed be donated and that his office had processed

the paperwork. He commented that of course I had obtained the necessary export license. Hadn't I? What export license?

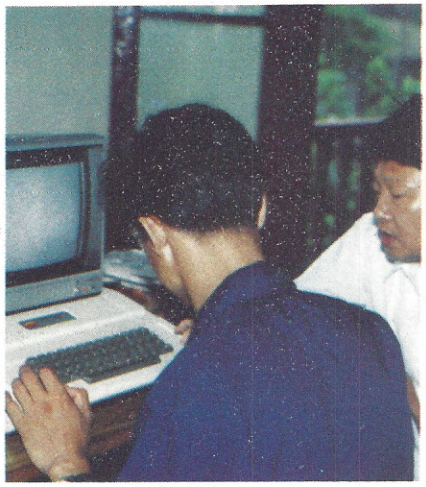
With a June 22 departure date, June 6 didn't seem like a good time for me to begin the process of obtaining the license. A couple phone calls confirmed that I had pushed myself to the wall. Not only did I require an export license to take a sophisticated piece of electronic equipment to "Red China," but learned that the process usually takes at least three weeks. A second phone call to the Department of Commerce in Philadelphia late Friday afternoon connected me with an efficient civil servant who placed the required forms in the mail. These forms arrived at 10 a.m. the next day. Bless the U.S. Postal Service (this time). I quickly filled out the forms and sent them by Express Mail to Washington, D.C., with a covering letter explaining the situation and requesting any possible consideration that could be given to process the application in time. By June 19, I had an Apple computer and an export license.

During this time there were other problems to be solved. China runs on 220 volts at 50Hz. An Apple power supply with a 110/220 switch readily took care of that. What kind of TV monitor could I find in China? My wife's sister put me in touch with an electronics expert living in Chicago who had done some consulting in China. I would have no trouble with an R/F modulator using UHF for black and white—surely the Chinese could do a lot without color. I considered buying a monitor here from my friendly computer store but that would be one more thing for us to carry through a couple of plane changes. At this point, a friend commented that if you can't get something in Hong Kong, it doesn't exist. Brilliant!

Enter Delta Communication

Fortunately, we spent over a week in Hong Kong. During that time I found several vendors selling a variety of microcomputers. One of the people I located was Raymond Ng of Delta Communication Service, distributor of Apple Computer in Asia. After several phone calls and a pleasant visit, Raymond convinced me that wherever the Apple was going, the folks using it would benefit greatly by having a color monitor. He then donated a nice color monitor and the required transformer. Now I had a complete system.

In the week we spent in Guangzhou, I gave demonstrations to several groups and many individuals. My wife's cousin introduced me at a factory and a research institute. At first many people thought a microcomputer must be a hand-held calculator. A brief demonstration made it clear that the microcompter was something else again.



A Chinese instructor eagerly tries his first program on an Apple II.

Few people at the factory had ever heard of a computer, let alone one that could be carried around. Following a short demonstration, however, one worker (after some coaxing) came forward and did some calculations in immediate mode. One institute I visited had a Chinese-made "Nova-like" minicomputer with external storage consisting of paper tape. The 80-column printer cost them about $55,000. I didn't ask what the computer itself cost. Needless to say, the Chinese were excited to see the Apple perform.

On July 28, we arrived in Hangzhou. The presentation of the Apple II Plus to Chekang Medical College was scheduled for August 1. Even though the college was closed for vacation at the time, the president, several instructors and several students were there. Setting up the equipment went like clockwork.

In addition to the machine itself, I added my books, some magazines and catalogs to the books which originally came with the Apple. Many Chinese interested in technical subject areas read English rather well. After running through some of the demonstration programs from Apple and some others which I prepared, I asked for volunteers. Several of the teachers had obtained a BASIC programming book written in Chinese so they were anxious to actually try out what they had been reading. In no time at all, one of the teachers had written and modified a short program. (I later met a man who had been teaching 8080 programming for two years without ever having seen the chip.)

I also had the opportunity to talk with eight instructors from the Computer Science Department of the University of Nanking. While there, I saw two Chinese computers and a printing terminal for a U.S.-made machine that had been sent off for repairs after the first week.

In Bejing I visited a factory and a research institute. Both had substantial Shanghai-made computers. The factory does its payroll for 6,400 workers on its machine. Each computer I saw could run BASIC or ALGOL. Several machines ran timeshared BASIC for 16 users.

The interest in microcomputers and microprocessors in China focuses on applications appropriate to Chinese problems. Microwave ovens, car braking systems, games and word processing hold little interest for the Chinese. One factory I visited is very interested in using a microprocessor for numeric control. The factory is currently using an analog device that reads punched paper tape to control a 30-ton milling machine. Development time could be shortened and the number of data points could be increased through the use of a microprocessor.

Now I am back home using my word processing system almost daily. The incredible experiences of the 'summer of 1980' are fading into the distance and I am on the lookout for an opportunity to make a return visit at some future time.

James S. Coan is author of Basic BASIC, Advanced BASIC *and* Basic FORTRAN.

RANDOM ACCESS

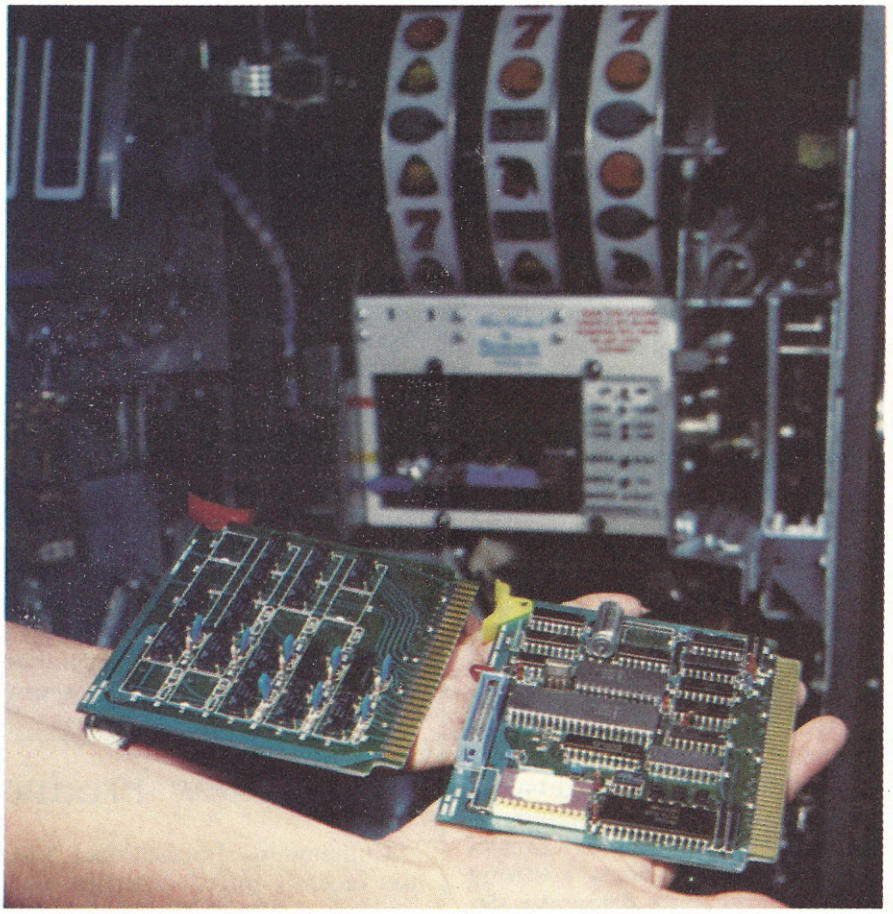
Computerized Slot Machines Okayed for New Jersey

Summit Systems, Inc. has been granted prototype licenses by the New Jersey Casino Control Commission for four models of microprocessor-based slot machines. A license from the Commission is a prerequisite before gaming products can be marketed and installed in New Jersey.

"Because the New Jersey gaming market is important and since New Jersey requires diversified sources for gaming equipment, this prototype approval is a very significant development for Summit," said James W. Halverson, president of Summit. Similar approval was received from the Nevada Gaming Commission earlier in 1980.

Summit plans to market its slot machine products exclusively through Summit Distributing Company, who have applied to the State of New Jersey to install these machines in the Playboy Casino in Atlantic City.

"Summit's microprocessor technology protects against slot machine cheating, reduces maintenance and downtime and provides computerized accountability and financial controls, while retaining full traditional player appeal," Halverson said.



Here is the heart of the computerized bandit: two palm-sized circuit boards. They are shown here in front of two full-sized slot machines.

400% Growth Forecast for Mini/Micro Peripherals

More than $3 billion worth of peripherals for minicomputer and microcomputer systems were shipped in 1980, and the 1990 forecast is for shipment levels to rise more than fourfold, despite a decline in the unit prices of most items. These are the conclusion of a new 208 page report from International Resource Development Inc., a market research firm.

Floppy disk drives, Winchester hard disk drives and other mass storage devices are expected to remain the single largest segment of the market, but the advent of 5¼" hard disks will reduce the average cost of mass storage per system. This will also hasten the trend towards smaller, compact desk-top computer systems.

Although the report expects a trend in some sectors towards "paperless" processing techniques, the overall usage of printers and paper in the "office of the future" is expected to increase. However, the continued trend towards distributed processing will bring with it a decrease in the average speed of line printers, the report said. Character printers and teleprinters used in conjunction with minicomputer systems will, however, continue to trend towards the 1200 baud level. Total printer shipments for mini/micro systems will exceed $1 billion in 1990, compared with some $500 million in 1980, the report said. Half of the 1990 shipment figure will be accounted for by non-

impact printers.

"Amateur" programmers—both in the home and business environments—are already finding out that even simple programs consume plenty of memory. According to the IRD research staff, adding on additional memory modules will become a "way of life" for many future mini/microcomputer owners. The report points out that memory prices will decline while labor costs increase, leading to an increased tendency to tolerate memory-inefficient programming techniques. An increasingly higher proportion of microcomputer products will have built-in telecommunications capabilities and will be used to access a variety of new information services and data bases, predicts the report. IRD also expects 1990 to bring $1.5 billion in mini/micro datacom peripherals.

"Desktop mini/microcomputers and CRT terminals are currently sitting on about two million desks in the United States," estimates Ruth Lipsitz of the IRD research staff, who compares this to the 40 million "white collar" workers in the U.S. labor force. "That makes one terminal or microcomputer for each twenty desks in 1981, but by the end of the decade, the proportion will be one in three," Lipsitz said. She also expects a strong trend towards more data entry devices being coupled to desktop mini/microcomputers, with a rapid upsurge in the use of speech recognition subsystems for data entry.

More than one hundred firms are currently manufacturing mini/micro peripherals. Lipsitz believes that steady price erosion and competition will result in more than half of them dropping out of the market. "Xerox Corporation, owner of floppy disk leader Shugart and daisywheel printer pioneer Diablo, may emerge as the leading supplier of mini/micro peripherals in the 1980's," Lipsitz said. She also sees Dataproducts and Centronics as potential challengers for the top OEM spot.

The report predicts a "very strong IBM presence" in the market. "Currently IBM's Information Systems Division is not a factor in the OEM peripheral market, but there are indications that several important new IBM printers and mass memory devices are going to be announced soon, and these could bring IBM into the OEM market with some excellent products," Lipsitz said. Other mainframers with significant production capacity for mini/micro peripherals include Control Data Corporation and Digital Equipment Corporation, according to the report. Data General and Prime are potentially important peripheral vendors "after they have caught up with the demand for peripherals to go into their own mini-systems," the report said.

Full details on the report (#164) are available from International Resource Development Inc., 30 High St., Norwalk, CT 06851; (203) 866-6914.

MINI/MICRO PERIPHERAL SHIPMENTS, 1980 - 1990
($ Million)

Peripheral, Category	1980	1982	1985	1990
Data Entry Equipment	240	370	915	1730
Printers	560	780	1010	1185
Memory	300	750	1150	1650
Disk/Tape	1000	1850	2565	2670
General Purpose Terminals	650	1100	1650	3450
Datacommunications Equipment	370	665	925	1915
Sub-Total	3120	5515	8215	12,600
Integral Peripherals	240	260	2115	17,400
Totals	3360	5775	10,330	30,000

(Source: International Resource Development, Inc.)

Three New Products from Commodore

Commodore International Ltd. has recently introduced three new products: the VIC 20, a full-featured, expandable color computer system selling under $300; the CBM 8096, a high capacity business computer with 96K of memory; and the 8060 series of disk drives, a generation of 8-inch floppy disk units offering multi-megabyte storage capacity and IBM 3740 data exchange format compatibility.

Color at Low Cost

The VIC 20 offers a full range of special features and expansion capabilities rivaling the features of existing microcomputers selling at four or five times the cost, Commodore said. It connects to any television set or monitor and provides 5K bytes of memory.

Features of the VIC (Video Interface Computer) include: color, sound, programmable function keys, memory expansion to 32K bytes, standard PETBASIC, full size typewriter keyboard, external expansion ports, 22 characters by 23 line screen display, high resolution graphics, graphics character set, joystick, paddles, lightpen, external plug-in memory and program cartridges.

According to Commodore Chairman Irving Gould, the company is "providing a computer system which helps almost anyone get involved in computing quickly and easily . . . with enough built-in expansion features to let the system 'grow' with the user as his knowledge and requirements become more sophisticated"

The VIC 20 is designed so a first time user can begin using it immediately with plug-in program cartridges, and build his system gradu-

ally as his needs (or budget) allow, Commodore said. System peripherals will include a tape cassette unit, single floppy disk drive, printer and a broad range of add-on accessories that tailor the system to a variety of special applications.

Additional special features, such as the computer's RS232C interface capability, make it possible to use the VIC with a telephone modem for accessing telecomputing services such as THE SOURCE and Micro Net or communicating with other computers. Special interface cartridges will also enable the VIC owner to use a wide variety of peripherals now on the market, Commodore said.

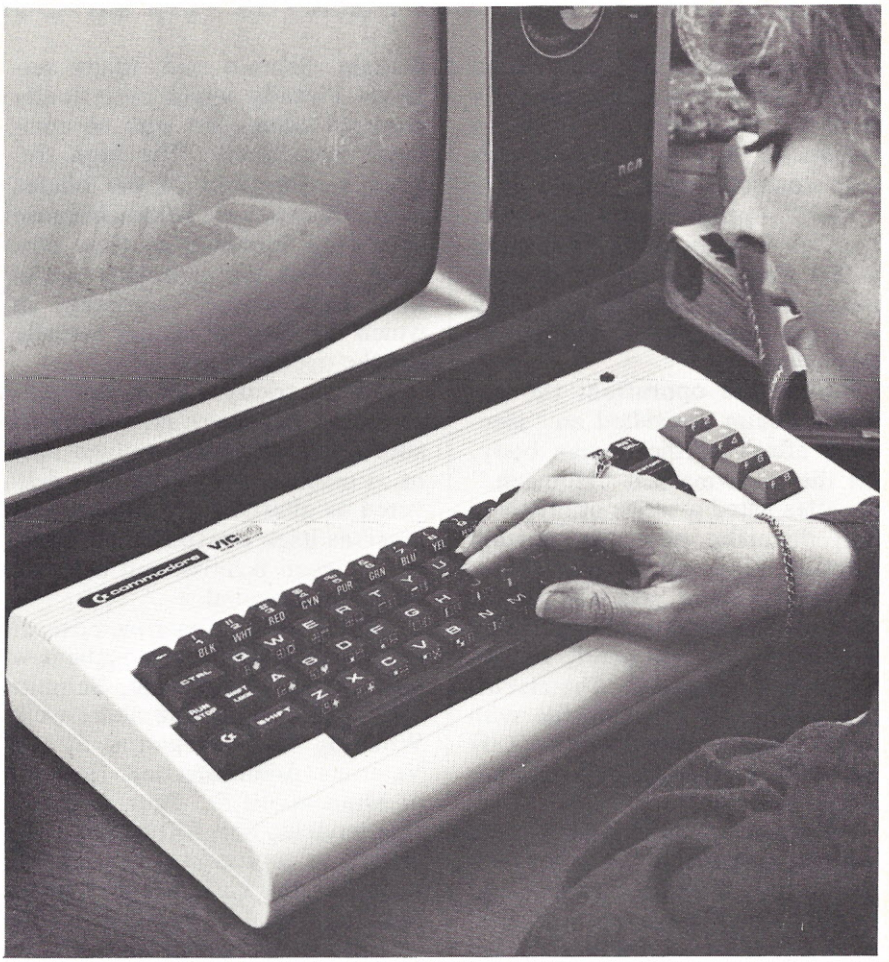
The new computer uses the industry standard 6502 "computer on a chip" technology, originally developed by Commodore's MOS Technology subsidiary. It also uses a new MOD Technology semiconductor device, called the VIC (Video Interface Chip), which incorporates Random Access Memory (RAM), Read-Only Memory (ROM) and video control circuitry all on the same chip.

Get 96K of RAM

The CBM 8096, an 80-column computer, provides 96K bytes of memory, a dramatic expansion in internal storyage capacity which permits large programs to reside in and cycle through the expanded memory space.

A wide variety of special programs containing computer languages such as FORTRAN and COBOL, or sophisticated data base management and information retrieval systems, become possible with this larger system, Commodore said. Expanded versions of VISICALC or OZZ also become possibilities, in addition to the vertical market applications opened up by the expanded storage capacity of a 96K microcomputer.

When used in conjuction with a high capacity disk drive, the Commodore microcomputer system begins to approach the internal/external storage capacity and power of minicomputers which retail for as much as three times the price of the system, Commodore said.



The Commodore VIC 20 uses PETBASIC to supply the user with color (22 by 23) graphics and sound. Other features of this under-$300 computer are: light pen, joystick and paddle controls, plug-in program cartridges. The VIC 20 is fully interfaceable to RS232C, and is expandable to 32K RAM.

8-Inch Floppy Disk Units

The 8060 series of disk drives includes the CBM 8062, with the ability to store and access 3.2 megabytes of information at one time (approximately 600 pages of standard typewritten information), and the CBM 8061, which can handle up to 1.6 megabytes. Both units have two vertical disk drives, but differe in that the 8061 reads and writes one side of the diskette, while the higher capacity 8062 reads and writes both sides.

Special advantages of the disk drives include: the highest data storage capacity available from Commodore for its PET and CBM microcomputers, compatibility with the IBM 3740 data exchange format, and compatibility with Commodore's smaller existing disk drive products.

The disk operating systems of the 8060 series are compatible with Commodore's one megabyte 8050 disk drive, as well as the smaller 2040 340-kilobyte drive. Consequently, programs written on any of the three disk drives may be translated back and forth through the CPU, using the appropriate programs.

All three products will be sold through Commodore's existing network of computer dealers in the United States, and potentially through other consumer outlets, the company said. For more information contact Commodore Business Machines, Inc., 950 Rittenhouse Rd., Norristown, PA 19403; (215) 666-7950.

Body's Own Electrical Patterns Aid In Computerized Surgery

A computerized electrical knife slides safely down the patient's throat. Manipulated like a marionette, it is on its way to perform stomach surgery. The knife is "smart"—programmed to adjust itself as it goes along. Vibrating 50,000 times a second, it quickly makes the extra moves necessary to avoid damaging a ring of the esophagus.

Before the operation, the patient's doctor consulted an "electrical atlas" of the human body. On the page marked "stomach," the atlas listed a series of numbers that describe how the normal stomach responds to electricity. Electrodes were attached to the outside of the abdomen and a painless electric current gently probed the patient's stomach. The electrical reading did not coincide with the "normal" range spelled out by the atlas, so the doctor's decision was to operate.

After the operation, the patient will monitor most of his or her own recovery at home with computerized medical equipment. One device performs regular blood tests, checking the effectiveness of prescribed medication at various times of the day. As the patient improves, he or she will check the "how goes it?" monitor evey day. This monitor reports pulse rate, blood pressure, visual acuity and muscle strength, telling the patient if he or she is headed for an especially good or bad day.

Right now, all of this remains science fiction, but just barely. Research leading to the "smart" surgical knives, an electrical atlas and computerized home medical equipment is well under way in the laboratory of Otto Schmitt, bioengineer, electrical engineer and biophysicist at the University of Minnesota. Schmitt already has nearly 60 patents to his credit and has given many others away to his students. He has been experimenting with electricity since he was five years old.

The idea of computerized knives for surgery is not completely a new thought, Schmitt said. Many surgeons already wield electrically powered knives but with no computer attachment. The high frequency vibrations of the blades currently in use are helpful because they stop bleeding as they cut. Such knives are especially useful for "endoscopic" surgery, in which the surgeon cannot actually see the operating site.

The electricity used is not particularly dangerous, Schmitt added. Although the voltage may be as much as 2000 volts, it is delivered as alternating current which reverses itself constantly, alternating between positive and negative electrical potential.

Adding the computerized aspect to these electrical knives is the new part of this technology, Schmitt said, and it is coming along well. Working with surgeons at the Veterans Administration Hospital in Minneapolis-St. Paul, a workable model is now 95 percent completed. A tiny computer chip attached to the knife handle adjusts the "electrical agressiveness" of the knife. Surgeons can easily change the speed with which the knife cuts, guide the knife to various depths automatically and switch swiftly from a cutting to a wound-sealing or drying pattern.

Schmitt's next step, which he is just beginning to work on, is to program this microcomputer chip to make its own adjustments, to be "smart." "We want to hand-make each electrical cycle and be able to change it every 5 to 10-millionths of a second," he said. Each programmed pattern would be erasable so it could be changed for the next patient's operation.

While working on the "smart" knife, Schmitt saw another problem—no one really knew how each kind of body tissue was affected by electricity. How much electricity does each organ soak up (its electrical resistance) and send back (its electrical reactance) at each frequency? Schmitt saw that an electrical profile of each organ, based on this two-part "impedivity" could be developed using 20 to 30 different frequencies. This problem led to his idea for an "electrical atlas" of the human body. Schmitt is now putting together such an atlas, a reference work with sets of numbers describing the normal electrical range for each organ at several frequencies. He finds the electrical limits for each organ by delivering safe electrical currents (100 to 400,000 hertz per second) to the organ and measuring what happens.

Once the normal numbers are in place, the atlas could be used to diagnose medical problems. A patient can be hooked up to the electrodes and the painless current will measure the reactance and resistance and compare it to the "normal" numbers listed in the atlas. This quick electrical measurement can diagnose problems caused by changes in blood vessels, fat cells and other factors. Emphysema and atherosclerosis should not be hard to diagnose, Schmitt said.

Preliminary "normal" electrical profiles, 66 numbers apiece, are now available for the heart, lung, stomach, esophagus, duodenum, colon, intestines, skin, liver, tongue, cheek, bladder, blood and fatty tissues, Schmitt said. Research is under way with teams from four Minneapolis-St. Paul area hospitals to refine measurements for the heart, which has long been known to have important electrical rhythms.

More experimental work is also being done on "live dogs, live rats, live graduate students and me," Schmitt said. Analysis of the brain is next. As new as it is, the procedure is much safer than X-rays, he added. The current can be concentrated on one organ at a time, several sets of data can be combined and the whole process can eventually replace much exploratory surgery.

Only about 10 percent of the atlas is now completed, Schmitt said, and many of the measurement instruments have had to be invented along the way. Some deep

internal organs are hard to reach, electrodes tend to fall off and measurements must be extraordinarily precise. Some unexpected individual differences are turning up, Schmitt said. A few people seem to have almost electricity-proof skin, and the skin of a man has a very different electrical profile than a woman's skin.

Even before the atlas is finished, there should be progress on the computerized medical devices for use at home, Schmitt said. Some already used in hospitals can be adapted for home use and others will have to be invented. Schmitt is now working on a "how goes it?" monitor, chronic care devices such as automatic massagers, heart-lung monitors with distress valves, "jitter" meters to measure nervousness, alcohol blood level monitors, sperm counters and body rhythm monitors.

— *University of Minnesota News Service*

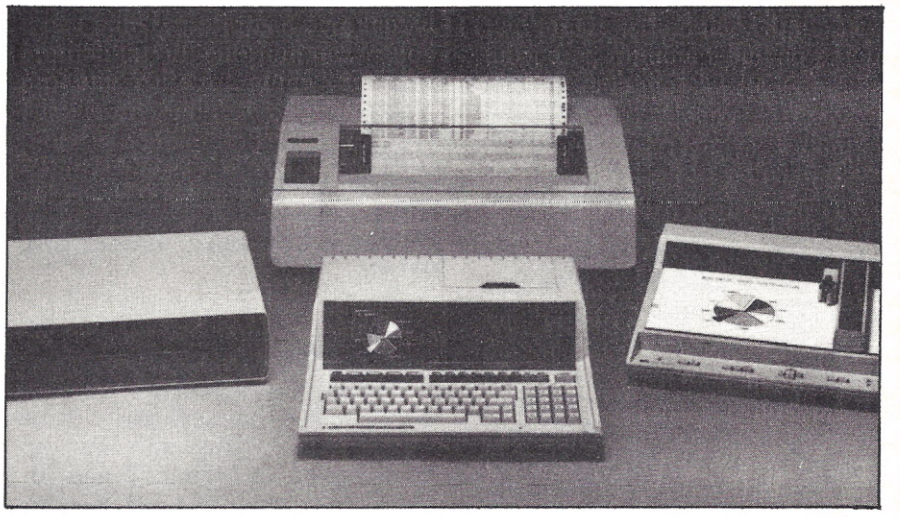
Lower Cost Computer and Business Software Announced by HP

By eliminating the built-in thermal printer and cartridge tape mechanism from its HP-85 personal computer, Hewlett-Packard has been able to produce another version of its personal computer that is about $1,000 cheaper than the original HP-85. Dubbed the HP-83, the new computer sells for $2,250 and is in all other respects identical to its predecessor. With the addition of the HP-83, Hewlett-Packard now refers to its personal computers as the Series 80 computers.

Like the year-old HP-85, the HP-83 is a typewriter-sized computer with an integrated high-resolution CRT and keyboard, enhanced BASIC language and unusually powerful graphics capabilities, Hewlett-Packard said.

Because of the availability of two types of floppy disk drives that can store between 270 kilobytes and 5 megabytes of data, it is no longer essential to have a built-in tape unit. Similarly, the availability of external printers and plotters that can work with the HP-85 make a built-in printer unnecessary.

In addition to announcing the new computer, HP has also introduced some new business software packages. These include the Information Management Pac, which provides a data base management tool for applications such as list-keeping, inventory and reporting, and the Graphics Presentation Pac for producing charts and text for reports and overhead projection transparencies.



A Hewlett-Packard Series 80 graphics system includes HP-83 personal computer, flexible disc memory, printer and graphics plotter.

The Series 80 machines also support HP's VisiCalc PLUS, an enhanced version of the "electronic worksheet" software that lets the user produce four-color charts and graphs from VisiCalc tables.

The Information Management Pac gives Series 80 systems a data base management tool for accessing, modifying, searching and sorting data. Data base totaling and statistics are included, as are report and graphics generation capabilities. Creating, updating and printing out customer or mailing lists, inventory records, catalogs, and other data bases are quick and simple with these programs, the company said. The list price for this package is $200.

The Graphics Presentation Pac is a set of programs that lets the user make four-color overhead projection transparencies or report copies of text, bar charts, pie charts and line charts. Management reports, customer presentations, sales seminars and other meetings and reports can all benefit from the graphics this package generates.

Three different character sets, nine variable letter sizes, and six different line and hatching styles are available. Greek and European characters, slanted or upright characters, three alternate highlighting styles (centered, underlined or both) and up to 25 slices per pie chart are other available features in this $200 package, Hewlett-Packard said.

For more information on these products, contact: Inquiries Manager, Hewlett-Packard Co., 1507 Page Mill Rd., Palo Alto, CA 94304.

☆☆☆ Announcements ☆☆☆

Microcomputers and Education Conference

The second annual tri-state conference, Microcomputers and Education, sponsored by CATALYST, Jersey City State College, will be held March 6 and 7. The conference will examine the uses of microcomputers in the school and college curriculum and ways to improve computer literacy at all levels of education.

Over a dozen speakers will participate in the conference. Ten main sessions, fifty workshops and over a dozen exhibits will be featured. There will be special sessions for administrators and teachers.

Conference fee is $75. For more information contact Microcomputer Conference, CATALYST, Jersey City State College, 2039 Kennedy Blvd., Jersey City, NJ 07305; (201) 547-3094.

CourseWare Magazine

Each issue of CourseWare Magazine, designed and documented for educational use, will be offered in three versions: Apple II, Pet, and TRS-80 Level II. Machine-readable programs will be provided on a cassette tape so they may be used right away by teachers and their students, or parents and their children.

Each issue of CourseWare Magazine will contain two programs selected from the pre-college curriculum areas of Business, Consumer Economics, English, Fine Arts, Foreign Language, Industrial Arts, Mathematics, Physical Education, Science, and Social Studies, or from the area of teacher-assistance programs.

Each student program in the magazine will be accompanied by a complete teacher's guide, a student's guide, worksheets (if applicable), suggestions on how to adapt programs for individual classroom lessons, a description of variables used in the program, and a full listing of the program. Teacher programs (computer managed instruction, computer supported instruction) will be accompanied by a user guide.

For more information contact Dr. Dan Isaacson, Editor and Publisher, School of Business, California State University, Fresno, CA 93740.

Designing Software

"Designing Software Education", a two-day seminar, will be held in four cities this spring: Washington on March 12 and 13, New York on March 19 and 20, Chicago on March 26 and 27, and Boston on April 2 and 3.

Developed for managers and training personnel charged with user and internal education, the seminar will focus on system documentation, classroom education, cassette workbooks, video production and computer-based instruction.

Registration is $540 per person. For more information contact Shirley Mixon Seminars, 501 Embers Dr., Marietta, GA 30067; (404) 955-3183.

Interface '81

The ninth annual Interface conference, devoted to data communications, distributed data processing and networking, will feature a 64-session conference and more than 200 companies on the exhibit floor.

Scheduled for March 30 - April 2 at the Las Vegas Convention Center, the conference will include 11 half-day seminars featuring national experts in discussion of various topics, including: DDP, Networking, Fiber Optics, Local Network Security, Satellite Strategies, International Networking, SBS and Its Alternatives, SNA '81 Update, Office Systems Planning, Business Graphics and Technology for Tomorrow.

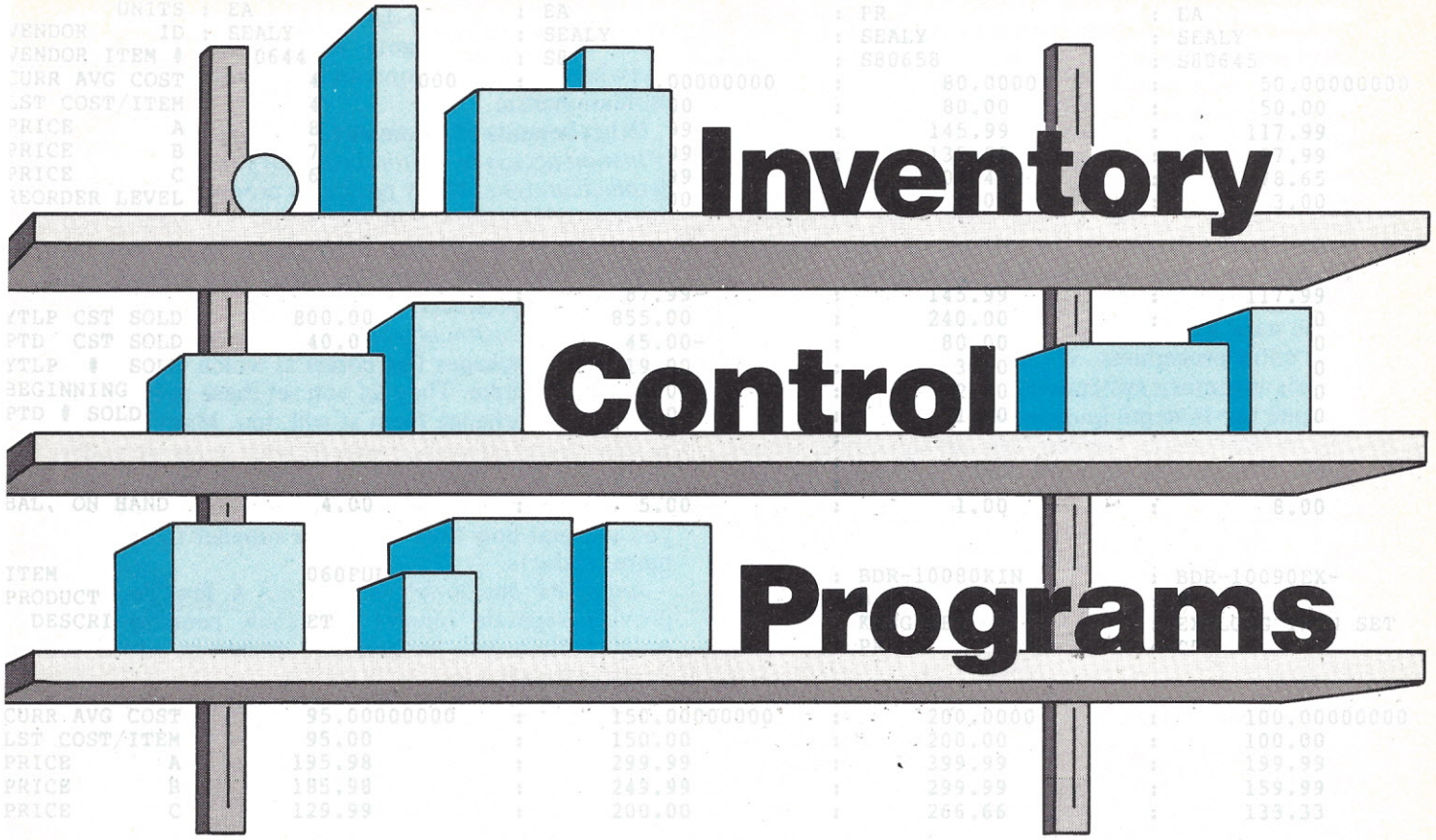
Registration fee for all four days of conference sessions and exhibit floor admission is $125; one day conference/exhibit floor admission is $65; exhibits only admission is $10. For more information on Interface '81, contact The Interface Group, 169 Speen St., Framingham, MA, 01701; (800) 225-4620. In Massachusetts: (617) 879-4502.

Executive Conference

Washington, DC is the site for the Executive Computer Conference to be held April 13 and 14. This two-day meeting, which has as its theme, "Improving Organizational Productivity through Systems Technology," will focus on key aspects of the computer's contribution to organizational productivity from a senior management perspective.

Trends in the use of computer technology to make planning, paperwork and personnel management more productive will be discussed. The impact of small computer technology and managerial decision support systems as they relate to organizational productivity will also be featured.

For further information, contact the conference chairman, Kendall Burroughs, The Executive Computer Conference, 1730 North Lynn St. Suit 400, Arlington, VA 22209; (703) 521-6209.



BY ROBERT L. PERRY

Inventory control is one of the most difficult and complicated operations for a microcomputer to perform, and choosing inventory control software that will give you the information you want can be as difficult as the operation itself.

Because the function is so complex, inventory software prices are generally higher than prices of other types of software. You can expect to pay between $100 and $850 for an inventory package. Even so, you may not find many packages to choose from. Unlike packages for word processing or the more common accounting functions—general ledger, accounts receivable and payable, and even payroll—inventory software is in short supply. And inventory systems with full functions that integrate with other accounting systems are even harder to find.

Type of Business

The single biggest problem in choosing inventory software will be finding one type that fits your business. Most inventory packages available today for popular microcomputers apply to "pseudo-retail" stores and small wholesalers and distributors who only buy and sell products. Seymour Merrin, president of Computerworks, a computer store in Wesport, Conn., says that most available programs simply will not handle the details demanded by manufacturers or retail stores larger than Mom and Pop operations.

Manufacturing operations usually require bills of materials and job costing; only one or two of the most expensive packages include these features. Hardware and appliance stores often must keep track of warranties by product model or serial numbers; no available package allows for that. And, Merrin adds, "Drug stores and pharmacies have huge inventories with complications such as prescription drugs and thousands of pieces. There are a few hard-disk-based systems, but they are not generally distributed."

So, who can benefit from an inventory package? Merrin and other experts say that small manufacturers who don't need bills of materials or job costing, a small stocking representative, and small retail operations and wholesaler/distributors who strictly buy and sell are the ones most likely to benefit from their use. For example, Custom Tailored Software Inc., of Wayne, N.J., originally designed one of its packages for a small Honda motorcycle dealership. The package is a simple parts inventory system for a 32K TRS-80 written in BASIC. It can store up to 2200 items on each mini-floppy. Custom Tailored has a larger program based on the Ohio Scientific C3 series, which was originally written to handle a parts inventory for an aircraft maintenance company.

Custom Tailored's president, Richard Auerbach, adds, "Another customer for our TRS-80 package is an electronics distributor. He keeps $300,000 worth of

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Robert L. Perry is the author of "Owning Your Home Computer" *(Everest House, 1981), and has served as consulting editor of Mechanix Illustrated's* "Personal Computers." *Mr. Perry owns an A.M. Jacquard I-500 mini.*

integrated circuits in four filing cabinets."

In general, Merrin says a company should meet three qualifications before it considers an inventory package:

- It should have an adequate cash flow to pay for the machine. Few small retailers qualify on this basis alone.
- It should be sufficiently well-organized to accept the changes computerization will bring.
- The company's staff should understand microcomputers well enough—or be willing to learn quickly enough—to insure a successful installation.

If the company meets these qualifications, he adds, "The most critical factor will be to guarantee correct data entry procedures. We recently computerized my store's inventory system with a Prodigy One system. Despite our in-depth knowledge of computers, it took five months to fully "debug" our administrative procedures. You have to make absolutely sure every packing slip, invoice, sales slip, check, prices, routine values, etc., are correct and entered into the system."

If you let your data entry slip, you may seriously damage your business. Most novices wrongly tend to trust any information a computer produces. But the input must be correct before the inventory package can do its job.

Automated Inventory

Despite these considerations, inventory automation can bring many benefits to a small business, including improved control of stock levels, improved customer service and improved cash flow. Of the benefits, the most important is the chance to improve customer service, says Ron Wong, president, AMD Consulting, Ltd., a New York City systems house.

"Automated inventory helps customer service best when many other companies sell the same product. Say a potential customer calls a plumbing outfit looking for a three-inch brass elbow. Usually, the distributor says, 'Wait a minute, I'll look in the stock room,' or refers to an out-of-date written card. While he looks, the caller could dial four other companies, and he probably will. With an automated inventory, the distributor would simply inquire on his terminal next to the phone and tell the customer that product's exact status in seconds. That gives him a strong competitive advantage over other suppliers."

The same system could also improve customer service *and* improve cash flow with a good backorder function. Wong notes that the computer can give you instant status reports and avoid running out of stock of any given item. You can also avoid annoying customers by making promises you can't keep. For example, suppose you have 20 widgets in stock and five on order. You have five committed to a new order, but a new order for 20 comes in. Under a manual system, you probably would not have recorded the five committed ones, and you may not remember the five on order. You look at your stock, and you tell the customer he can have his 20 widgets. Either your first customer will not get his widgets and will be annoyed, or the second customer will be short five widgets.

With the computer, you can query about the item, and, with most packages, find out the quantity on hand, the quantity on order, and even the quantity backordered. You ask the customer whether he will take 10 now and 10 in a few days. You could probably tell him when you expect a new delivery of widgets. Even if he must have the widgets immediately and buys elsewhere, he will be impressed with your honesty and professionalism.

Other benefits of automated inventory include:

Instant access to the total value of your inventory for detailed analysis. Many programs produce gross profit margins which show you where and how your inventory dollars are invested. With this analysis, you can beef up your most profitable stock and reduce your slow-moving products.

Reduced investment with monitoring of the inventory flow. Most packages flag points at which you wish to reorder each item. They let you set these points yourself; you can change them at will, too. Many produce reorder reports that show exactly what items are understocked and by how much. A good package will compute suggested order quantities based on the amount you sell and how long it takes a supplier to ship you more products.

Improved backorder fulfillment. A few packages provide separate reports that show pending backorders; others give backordered quantities on the Inventory Master List.

Easier physical inventories. Many packages provide "physical inventory worksheets" that list item numbers, descriptions, quantities on hand, sales and so forth, and provide a space for reconciling the "book inventory"—the figures in the computer—with the actual physical count. Many packages require you to take a physical inventory to set up the system for the first time. This step gets you started off with an accurate count and an accurate system.

General accounting interface. A few packages interface with the general ledger and other accounting functions. This can save your staff an enormous amount of time spent with calculator, pencil and paper.

Improved control of shrinkage. Keeping close tabs each day on your actual inventory will help prevent popular items from slipping between the cracks or into slippery fingers.

Instant calculations and extensions. Often overlooked as an important advantage is a computer's ability to automatically multiply or "extend" the cost or price of an item by the number in stock (10 items in stock at a cost of 25 cents, or a total cost of $2.50, for example.) All packages provide this function and eliminate the drudgery long associated with inventory control. They also automatically calculate the total value of inventory; some packages break it down by product classes or departments. As noted, many packages also provide gross profit margins for each item, different categories of items, or items sold by different departments.

Taken together, these advantages provide very powerful analytical tools that can, when used correctly, improve the profits of a small business.

Features and Functions

An inventory system has three fundamental functions: To keep track of the activity (sales and receipts) of each item of stock; To determine what a company's demand for each item should be, and; To make sure each item is replenished when necessary.

In short, inventory is simply the business procedure

RUN DATE 9/26/80 — HOWELL ENTERPRISES, INC. — PAGE 2

INVENTORY SYSTEM

INVENTORY PRICE LIST

DEPARTMENT BDR

ITEM ID	P C	DESCRIPTION	VENDOR ID	VENDOR ITEM #	UNIT	CALC. BALANCE	PRICE A	PRICE B	PRICE C	COMMENTS
BDR-10000TWI	B	TWIN MATTRESS	SEALY	S80644	EA	4.00	87.99	77.99	65.99	
BDR-10010TWI	B	TWIN FOUNDATION	SEALY	S80645	EA	5.00	87.99	77.99	65.99	
BDR-10020TWI	B	TWIN SET	SEALY	S80658	PR	1.00	145.99	135.99	109.49	
BDR-10040FUL	B	FULL MATTRESS	SEALY	S80645	EA	8.00	117.99	97.99	78.65	
BDR-10050FUL	B	FULL FOUNDATION	SEALY	S80647	EA	10.00	117.99	97.99	78.65	
BDR-10060FUL	B	FULL SET	SEALY	S80659	PR	2.00	195.98	185.98	129.99	
BDR-10070QUE	B	QUEEN SET	SEALY	S80636	PR	3.00	299.99	249.99	200.00	
BDR-10080KIN	B	KING SET	SEALY	S80634	PR	2.00	399.99	299.99	266.66	
BDR-10090EX-	B	EX-LONG TWIN SET	SEALY	S80605	PR	1.00	199.99	159.99	133.33	
BDR-11000BED	B	BED FRAME	FRAMCO	S80622	EA	14.00	59.99	49.99	40.00	

DEPARTMENT TOTALS — NUMBER OF ITEMS= 10 — NUMBER OF UNITS= 50

A sample output from Peachtree's inventory program.

with which a company tries to make sure it has the necessary amount of products on hand to fill orders without running out, Wong says.

To carry out these three functions, however, there are many ways to structure a system. They range from the very simple, producing four or five reports, to the highly complex, including job costing analysis, bills of materials and complete integration with six other accounting packages. Many of the packages considered here are simple, but others have features that make them a cut above the average.

The basis of any inventory system is a master file (or list). A fundamental master file contains all of the information about each item, also called a record, a company wishes to store. A master file should be considered the inventory's "data base." A basic record consists of: part number, part name (or description), quantity on hand, unit cost, total cost, unit price and total price. Each of these parts of a record is called a "field," and will hold the actual data you wish to store.

Those seven fields are just the beginning. Some master files, such as Peachtree Software's contain 25 different fields. Many have a dozen or more. The more fields a master file has, the more ways you can sort, search and arrange the information into various reports and listings.

Each inventory package consists of programs that carry out the desired functions. Auerbach says these programs "build and maintain the data base and extract and display pertinent information."

In most systems, the first program maintains the inventory and lets you add, delete, change or correct data on each item. You'd also make inquiries or queries with this program. Some maintenance programs also make adjustments—returns, shrinkage, overages, etc.—for each item.

Second and subsequent programs enter transactions, print or list the master file, and produce reorder, back order, activity, and period reports, such as month-to-date, end-of-month, year-to-date and end-of-year reports. The ones that are available in each package vary widely.

Here are the features found in reports and lists—first the common, then the exceptional:

Transaction Entry (or sales report). Most packages simply record sales and receipts; good ones also keep track of returns and adjustments. This report also uses part or item number and description, date, quantity, and unit cost and unit price information. It calculates total cost and price; better packages add sales tax automatically.

Exceptional features include entries for the effect of the transaction on the amount of inventory and its value; product and transaction codes; and gross profit margins.

Physical Inventory Worksheet. Only a few inventory packages produce this worksheet, and only one or two let you choose those records or items for which you want to print worksheets. As noted, the sheets usually include item or identification (ID) number, description, unit of measure, quantity listed and a space for actual quantity counted during the physical inventory. Once you take an actual count, you use the worksheets to manually step through your master file and make corrections.

Exceptional packages will add location codes, bin numbers, and vendor name and number. Compal's system will also sort and print the worksheets by location and bin number, making the actual count extraordinarily easy.

Reorder Report. Most packages present a list of all items with a quantity on hand less than or equal to a specified number. For example, an item with a reorder level of 10 and an on-hand quantity of 10 will appear on a reorder report; the same item with 12 pieces on hand will not appear.

This list usually consists of item ID number, description, quantity on hand, reorder level (or point) and specified reorder quantity. Exceptional reorder reports add the number of weeks below the reorder level, vendor name and ID number, quantity back-ordered if any, last cost, lead time (in weeks), items on order and quantities, and average sales or usage per period.

Month-to-Date Report. All inventory packages have reports that track transactions according to time periods. The most common are month-to-date, in which each month's sales and receipts are started anew, end-of-month summary and year-to-date and year-end reports.

As each transaction is entered in the transaction entry or sales journal program, the computer automatically updates the month-to-date, year-to-date, and end-of-month and end-of-year files. These reports usually include net sales—in units and amounts—and cost of goods sold, along with item numbers and descriptions. Complex programs, such as those sold by Peachtree Software, BPI, and Compal, add profit margins (in dollars figures and percentages) and cost of goods sold as a percentage of sales. For example, an item with a retail price of $1 that costs 60 cents would have a margin of 40% and a percentage of sales of 60%. Another useful feature is the average selling price.

PAGE 1

REPORT DATE: 4/07/80 — HANK'S HARDWARE CO. TRANSACTION LISTING

TRAN TYPE	ITEM NUMBER	DESCRIPTION	TRAN QTY	UNIT COST	EXTENDED COST	UNIT PRICE	EXTENDED PRICE	GROSS PROFIT
RECEIPTS	NA-C-08	#8 COMMON	250	1.20	300.00			
RECEIPTS	NA-F-1	1" FINISHING	200	.19	38.00			
RECEIPTS	SA-C-10	# 10 CROSS CUT	35	8.90	311.50			
RECEIPTS	NA-C-04	#4 COMMON	300	1.17	351.00			
RECEIPTS	SA-R-10	# 10 RIP	20	8.75	175.00			
SALES	NA-C-10	#10 COMMON	50	1.15	-57.50	1.85	92.50	35.00
SALES	SA-C-24	# 24 CROSS CUT	2	9.24	-18.48	12.95	25.90	7.42
SALES	HA-C-12	12 oz. CLAW	6	8.75	-52.50	9.95	59.70	7.20
SALES	NA-F-2	2" FINISHING	27	.17	-4.59	.69	18.63	14.04
RETURNS	HA-C-16	16 oz. CLAW	1					
RETURNS	HA-B-10	10 oz. BALL-PEEN	2					
ADJUSTMENTS	HA-T-08	8 oz. TACK	31					
ADJUSTMENTS	NA-C-06	#6 COMMON	273					
TOTALS:	SALE COSTS:	133.07	RECEIPT COSTS:	1,175.50	1,042.43		196.73	63.66

A sample output from a run on COMPAL's inventory program.

Good programs also let you sort these reports by different categories. Peachtree Software, for example, lets you sort by up to 10 product codes (0-9). Year-to-date and other periodic reports simply extend these figures for all items for the length of the period.

The following reports are found *only* in more complex inventory packages:

Inventory Price Lists. The computer generates a complete list of all items and their prices. Several packages let you enter more than one price, an important feature, the experts say. Peachtree lets you insert three different retail prices: a) regular retail, b) discount, and c) special sales or bulk quantity price, for example.

Departmental Summary. Those programs that let you establish department codes also will sort by these departments and produce a summary for each one. This summary usually includes the totals of the following data about all inventory items in each department: current value; percentage of total inventory value; year-to-date sales; year-to-date cost of sales; each department's percentage of total sales and total costs; year-to-date gross margin; and total margin.

Backordered Items Report. This report simply lists the ID number and description of each backordered item, the date the order was placed and the quantity of each backorder.

Items on Order Report. You can also compare your outstanding purchase orders with your backorders with this report. In addition to the item number and description, it lists the vendor, the quantity ordered, the date the order is due, the cost of the order and the total cost of each item.

Critical Factors

No one inventory package contains all of the features, functions and reports discussed above. But the features and functions some experts consider to be critical are:

On-line inquiries. Can you call up one item on the screen for a quick inspection, or to respond to a customer's question?

Activity reports, or ABC analysis. Can you easily identify your fast- or slow-moving items by product class, item number, vendor or description?

Types of costing. How does the package determine the cost of items when more than one cost for the same item occurs? This is a complex accounting area in which most packages fail to provide a good solution. For example, suppose you buy five widgets that cost $1 each one week, and you buy 3 more widgets at $1.50 the next week. How can the computer calculate the most accurate average cost of all widgets?

If you use the *standard* costing method, all of your widgets will be calculated at the higher cost. In our example, the cost per widget would be $1.50. A more common method, *average cost,* would add $1 and $1.50 and divide by 2 for an average cost of $1.25, more accurate, but not as accurate as *weighted average costing.* Weighted average costing would divide the actual purchase price—$9.50—by the number of items—8—for a cost per widget of $1.18, a very accurate figure.

BPI Systems adds two advanced costing methods: Last In, First Out (LIFO), and First In, First Out (FIFO), to an average costing method, and lets you choose the one you want. But BPI warns that LIFO and FIFO may have serious tax consequences, and recommends the advice of an accountant on which method is best for you.

Automatic interface to other packages. Gary Sawyer of Lifeboat Associates says that a crucial factor is whether the inventory package integrates with the general accounting package. He and Merrin believe this integration is essential. There are not many inventory packages that actually integrate to a full accounting system available for 32K-64K micros with floppy disk drives. BPI Systems, Compal, The Bottom Shelf, DBIS, Taranto & Associates, and a few manufacturers that make large micros offer packages that link directly to others.

There are two other important factors that *no* micro package has at this time: a direct link to a cash register program; and a listing of items committed or sold, but not delivered. Wong says these two are important, but require more RAM than a micro has available. Retail Sciences, which produces Peachtree Software, is said to be preparing a cash register program that links to its inventory package.

Human Engineering

These missing links point out the limitations of any micro-based inventory system. Despite these limitations, however, they can basically carry out the required functions, Merrin says, if they are "engineered for people."

Although "human engineering" is a buzz phrase in the micro industry, Merrin, a former chief executive

officer for a division of Exxon Enterprises, offers a precise description of a system that has been "human-engineered."

First, the system must have easy-to-follow menu screens. "Even if an operator hasn't read the documentation, he or she should be able to use the system with little difficulty," he notes.

Second, the documentation must be understandable to someone with a seventh or eighth grade reading level. It should walk the operator through each step in the system and use charts and displays to explain the system's functions.

Third, an operator should be able to proceed step-by-step through the system with the least possible disk flipping and switching.

Fourth, hitting the wrong key should not harm the data, or bounce the operator out of the program; that is called "error tracking."

Fifth, the operator should be able to get out of the sequence when he or she wants to. "Some programs require you to finish an entire sequence before you can get out of the program." Merrin says a good program will require, at most, two steps to allow an operator to exit the program.

Sixth, print routines should be automatic, or require only one or two keystrokes.

And Sawyer, a software specialist, adds two more critical human-engineering factors: "The numbering system you use in the computer inventory should be as close as possible to the one you use for your manual system. If it's quite different from the one you used before, it could lead to serious trouble."

He also insists that a system should provide for various price levels—at least three—and multiple suppliers of the same item. These features will assure that the package is actually "user-friendly," another buzz phrase that everyone uses, but few implement.

A Note On Warranties

Warranties on inventory software, like all microcomputer software, range from excellent to non-existent. Galactic Software and B.E.C. (Business Enhancements Compuservice) offer one-year full replacement warranties. The most common warranties are 60-day and 90-day full warranties with replacement charges. Some manufacturers, including BPI, do not offer any warranty.

Unfortunately, the packages from companies offering the best warranties tend to be more limited than the packages with advanced features—for which warranties are less comprehensive or non-existent.

Individual Software Packages

With all of these features, functions and factors in mind, let's compare the inventory control packages offered for major microcomputers, including the TRS-80 Models I and II, the Apple II Plus, the Commodore PET and CBM series, and CP/M compatible computers. (All of these offer 32-64K RAM systems with either two mini-floppies or 8-inch disk drives, and are within the price and capability range of businesses doing under $500,000 a year in sales)

The Vendor Guide compares the configurations and prices of each package. The table compares each package's functions and features. The list of questions will help you prepare to search for the package that will

MARTIN'S MENSWEAR--WAREHOUSE #1 — PAGE 1
INVENTORY — DATE 10/2/79

STOCK ACTIVITY REPORT
ITEM NUMBERS RANGING FROM A180-001-5 THROUGH A250-025-1

REC NO.	ITEM NO.	DESCRIPTION	CURRENT STOCK	RETAIL PRICE	UNIT COST	STOCK VALUE		ADD-ITIONS	DEP-LETIONS	NET CHANGE
B1	A180-001-5	Suits, wool knit, short	125	200.00	100.00	12,500.00	CURRENT MONTH:	0	25	-25
							YEAR TO DATE:	0	25	-25
B2	A180-001-6	Suits, wool knit, regular	150	210.00	105.00	15,750.00	CURRENT MONTH:	0	50	-50
							YEAR TO DATE:	0	50	-50
B3	A180-001-7	Suits, wool knit, long	45	210.00	105.00	4,725.00	CURRENT MONTH:	0	25	-25
							YEAR TO DATE:	0	25	-25
B4	A180-001-8	Suits, wool knit, X-Long	0	220.00	110.00	0.00	CURRENT MONTH:	0	25	-25
							YEAR TO DATE:	0	25	-25
B5	A180-002-5	Suits, wool knit, vested, sht	65	225.00	110.00	7,150.00	CURRENT MONTH:	45	0	45
							YEAR TO DATE:	45	0	45
B6	A180-002-6	Suits, wool knit, vested, reg.	115	230.00	115.00	13,225.00	CURRENT MONTH:	15	0	15
							YEAR TO DATE:	15	0	15
B7	A180-002-7	Suits, wool knit, vested, long	75	240.00	120.00	9,000.00	CURRENT MONTH:	50	0	50
							YEAR TO DATE:	50	0	50
B8	A180-002-8	Suits, wool knit, vested, X-lg	38	250.00	125.00	4,750.00	CURRENT MONTH:	28	0	28
							YEAR TO DATE:	28	0	28
B9	A180-005-6	Suits, Gabardine, regular	200	175.00	100.00	20,000.00	CURRENT MONTH:	0	0	0
							YEAR TO DATE:	0	0	0
B10	A180-005-7	Suits, Gabardine, long	100	175.00	100.00	10,000.00	CURRENT MONTH:	0	0	0
							YEAR TO DATE:	0	0	0
B11	A187-016-5	Sportcoats, wool, short	30	100.00	50.00	1,500.00	CURRENT MONTH:	0	0	0
							YEAR TO DATE:	0	0	0
B12	A187-016-6	Sportcoats, wool, regular	50	100.00	50.00	2,500.00	CURRENT MONTH:	0	0	0
							YEAR TO DATE:	0	0	0
B13	A187-016-7	Sportcoats, wool, long	20	100.00	50.00	1,000.00	CURRENT MONTH:	0	30	-30
							YEAR TO DATE:	0	30	-30
B14	A250-001-1	Dress shirts, cotton, small	0	15.00	10.00	0.00	CURRENT MONTH:	0	0	0
							YEAR TO DATE:	0	0	0
B15	A250-001-2	Dress shirts, cotton, medium	150	15.00	10.00	1,500.00	CURRENT MONTH:	0	50	-50
							YEAR TO DATE:	0	50	-50
B16	A250-001-3	Dress shirts, cotton, large	25	15.00	10.00	250.00	CURRENT MONTH:	0	75	-75
							YEAR TO DATE:	0	75	-75
B17	A250-023-1	Dress shirts, polycotton, sm.	300	12.00	6.00	1,800.00	CURRENT MONTH:	0	0	0
							YEAR TO DATE:	0	0	0
B18	A250-023-2	Dress shirts, polycotton, med.	400	12.00	6.00	2,400.00	CURRENT MONTH:	0	0	0
							YEAR TO DATE:	0	0	0
B19	A250-023-3	Dress shirts, polycotton, lrg.	100	12.00	6.00	600.00	CURRENT MONTH:	0	0	0
							YEAR TO DATE:	0	0	0
B20	A250-025-1	Dress shirts, polycotton, sm.	100	14.00	7.00	700.00	CURRENT MONTH:	0	0	0
							YEAR TO DATE:	0	0	0

Hard copy output from SSG's inventory program.

fulfill your requirements. At the end of the guide is a list of software houses and manufacturers including some whose inventory packages were not evaluated for this article.

The *Peachtree/40 Inventory System* is an excellent package that runs on a 48K Apple II Plus with the Z-80 Softcard from Microsoft, and Microsoft BASIC with a CP/M operating system. Although each diskette will hold only 700 items, the package more than makes up for it with advanced features and functions. Included in its 25 Master File fields are such exceptional features as: a choice of 10 product codes; three price levels; returns and adjustments; a three-character department code; average cost; last cost; reorder level, quantity and date; and vendor identification number and vendor item number (a serial or model number.)

The package is completely menu driven and has many of the "user-friendly" features the experts prefer. The package is made up of 13 programs, each of which produces one report or listing. Several of these reports are advanced, especially the departmental summary report, month-to-date and inventory status reports. The most impressive thing about the system is its manual. It is written simply, explains every procedure step-by-step, and gives examples of screen displays so an operator will know what to look for when using each function.

BPI Systems, Inc.'s *Inventory Control System* runs on the Apple II with 48K RAM and requires a ROM Card, two disks—one with the disk controller—an 80-column printer, and a Sup-R-Mod RF modulator. This, too, is considered to be among the two or three best packages. Its main advantage is that it completely and automatically integrates to the BPI general ledger and accounts receivable packages. It is also the only package that generates purchase orders, price labels for any item, trial balances, skeleton general ledgers, and general journals. It can also merge with any other accounting system with single journal entry, and it creates its own general ledger for double entry auditing control.

The system uses three floppy disks: a Data Entry Disk for all entries; a Posting Disk which posts all entries from the Data Disk into its own ledgers and then integrates them with other packages; and a Maintenance Disk which begins the system and is used to edit existing records.

It operates with a unique function called a "queue." Each function is programmed as a separate command; the system has more than 90 commands. You can stack up to eight commands in the queue and execute them in sequence. For example, you can enter commands 11, 12, 13, 14, 15, 61 and 62 enter purchase orders, enter merchandise purchases, enter the invoice register, adjust inventory, enter the general journal, list inventory and produce price labels all in sequence order. Within each command, too, there are menus of sub-commands that give you choices. The menu for command 11 lets you enter purchase orders, process back orders, process low-balance items, or end the menu.

It has a remarkable capacity for these features: 800 items for one data disk in a two-drive system, or up to 2,000 with three drives. You can use Apple 3.3 DOS and add 15% more capacity, 920 and 2,300 items respectively.

The system has dozens of advanced functions, including six different types of sort operations, including sort by description. It will also allow a six-character description search; that is, you could search for all items whose product name started with EUREKA or SEALY or any other name.

It is the only package that gives three costing methods—LIFO, FIFO and average—and one of the few that includes an entry for automatic sales tax computation. You can enter up to two digits and two decimal places, i.e., 10.75%, as your sales tax, and the system will automatically add it to the total price.

It is a more difficult system to use, although the manual is well-written and clear, because of its advanced reports and features. It also requires strict numbering systems if you integrate the systems with other BPI accounting systems.

Most important, BPI has recently signed an agreement with Apple that makes the manufacturer the exclusive distributor of BPI software. Some dealers expect this to reduce their demand for BPI software, because Apple has lowered their profit margins on BPI products, while others believe BPI products will gain a much wider distribution with Apple handling them.

Structured Systems Group, Inc.'s, *Inventory Control* is an adequate system that runs with any 8080- or Z-80-based CP/M system with 48K RAM and two disk drives with a minimun capacity of 200K, and a 132-column printer. It also uses the current version of CBASIC, but offers a range of four disk formats, including the 8-inch IBM-standard single density.

It has a large capacity of up to 3,000 items on a dual eight-inch, double density drive, and up to 4,000 items on four eight-inch single density drives. Each item record uses 200 bytes.

It generates six lists and reports, including two audit "proofs" for additions and deletions, an activity report for slow-moving stock analysis and a reorder report. It has a versatile item numbering system, allowing alphanumeric characters and dots and dashes. It has a long—30 characters—description field, and a good master or Item File. The master file fields include such advanced features as disk drive location, separate record and item numbers, reorder point and quantity, date ordered and date due, and quantities on order and backordered.

Another important feature lets you select a range of item numbers to examine for any of three reports. For example, you can get a reorder report for item numbers 100 to 199; you don't have to examine the whole file if you don't want to. This is SSG's most competitive feature.

The Bottom Shelf's *Inventory Control System* is only supported on the TRS-80 Model II. It's a new system based on a complete general accounting package which has been under development for more than two years. The GA package itself is an upgraded version of programs originally written for the IBM 5120 and 5110. Its capacity is limited to 1,800 items per eight-inch, double density disk, but company officials say they are already testing it on a new five-megabyte hard disk.

This is a high-end, sophisticated system that integrates into five other modules now, and, soon, into vertical software, such as a bill of materials processor. The system requires 64K RAM, four eight-inch drives and a 132-column printer. It includes an advanced search and sort capability; for example, you can sort by item number and search by warehouse, category or

group of item numbers. It also has a full-scale order entry module included in the inventory package.

Each item has three price levels, sales tax label, an individual salesman's commission rate, multiple vendors, multiple bin locations, and different general ledger accounts. The commissions can be sent to different accounts, and the order entry facility updates GL, accounts receivables, customer files, a temporary customer file and ship-to-address files automatically.

TBS also plans to offer a unique service program. It will sell demonstration disks to the dealers for $50, and require customers to test the demo disk first. The company will offer a 30-day money-back guarantee, and a 90-day full warranty. After that ends, TBS will have a "Retainer Service" that will give customers a flat number of service hours by telephone for $100; for $125, you can hook up to them with a modem, and TBS will provide a "host-compatible" link and fix your software by telephone.

Radio Shack's TRS-80 Model II *Inventory Management* software requires a 64K single disk Model II with a 132-column line printer. Its capacity is up to 3,000 line items and 200 vendors. An exclusive feature is an inventory projection that analyzes actual sales for the previous 12 months, and projects each item's sales trend. It also uses ABC codes to separate items into three groups: fast-moving, average and slow-moving for better control.

It has an inventory performance report that summarizes overall performance, ABC Code performance and ABC code history at the end of a fiscal period. Its master file summary separates all products into five ABC classes and summarizes their last cost, current price and gross margins. In addition to common reports such as transaction posting, master list and suggested order list, it provides a physical inventory error report and a vendor listing.

Galactic Software's *Inventory Master* runs on a TRS-80 Model I or III with 48K RAM, two to four disk drives (only two for the III) and a 132-column printer. It will track 2,700 items on a four-drive Model I and a two-drive III with an unlimited number of vendors. It has machine language routines that can sort all 2,700 items in about 15 seconds, fast by any standard.

The program lets you access items by vendor and part number, or by its own index number. You can

REPORTS TABLE

	Master File	Transaction	Phys. Worksheet	Price List	Dept. Summary	Inv. Status	Reorder	Month-To-Date	Year-To-Date	End-Of-Period	P&L Report	Trial Balance	Gen'l Ledger	Over/Under	On Order	Backorder
Peachtree	■	■	■	■	■	■	■	■	■	■						
BPI Systems[1]	■	■	■	■		■	■	■	■	■	■	■	■			
SSG, Inc.	■	■		■		■	■									
TBS[1]	■	■		■		■	■	■	■				■			
Radio Shack	■	■	■		■	■	■			■					■	
Galactic[2]	■	■		■			■							■	■	
Custom Tailored	■	■					■			■						
COMPAL[3]	■	■	■			■	■	■	■	■					■	■
Serendipity	■					■	■	■	■						■	
B.E.C.	■	■				■	■	■	■							■
COMPUMAX[4]	■	■				■								■		
Computer Place	■	■				■	■		■						■	
Micro Architect	■	■			■	■				■						
DBIS	■	■		■		■			■							
CMS Software	■	■	■	■				■	■					■		
Micro Computer Industries	■	■		■		■										

NOTES: 1. Package integrates with general accounting system
2. Also has report on out-of-stock items
3. Also has a receipt-of-backorders report and a physical inventory adjustments report
4. Has job costing program and Economic Order Quantity notification

assign a "selection code" to each item so you can track similar items according to similar codes. The computer will also generate a purchase order, but the order file is batch-processed. Daily sales transactions are also batch-processed; the system can handle up to 190 sales per day. Its seven reports include a good one on overstocked items as well as sales, cost/price, recommended orders, on-order and out-of-stock items.

Galactic's warranty is excellent with one full year for coding defects, but buyers must register their purchase within 30 days, using Galactic's registration card.

Custom Tailored Software, Inc.'s, *Parts Inventory System* is designed for small distributors, stocking representatives or retail stores. Undergoing modifications in January, 1981, the program runs on the TRS-80 Model I with two mini-floppy disk drives. It can store up to 8,000 items because the system's fields are limited. The system consists of six programs: file maintenance; a master list; a reorder report; a monthly sales activity report; a daily activity report; and an on-hand report. Its master file is limited to seven fields. Despite its small number and size of fields, it does provide on-line inquiry and the basics of an adequate system. The system has one unique feature: a random number generator that produces random items for a physical inventory check. This will help reduce shrinkage if no one knows what items are going to be spot-checked.

Custom Tailored is also working on a much more powerful inventory system for the Ohio Scientific C3 series that will handle more than 10,000 parts with about 20 programs. The system stands alone now, but Auerbach says the "hooks" have been left open for integration to a complete GL system.

COMPAL Computer Systems, Inc. makes an excellent package with more advanced features than other systems. It runs on the Compal 8000 computer, or any CP/M-based system with 56K RAM, 630K bytes of storage on two eight-inch disk drives, an upper/lower case keyboard with a 10-key numeric pad, and a high-speed printer. It will store up to 3,000 items in any number of locations and 1,296 product classes; one dual drive system will store 1,000 items and 500 backorders. The system is designed so that line items and backorders trade off; you can store 900 items and 1,300 backorders on one dual drive. The maximum of 3,000 items is reached on four drives.

The system allows the user to specify many features, such as ABC high-dollar analysis and six usage periods. The system integrates to the company's general ledger, order entry and accounts payable systems. It has an exceptional physical worksheet printout that is sorted by location or bin sequence, making an actual count very easy. It has a good order entry function with three price points and sale tax, discount and commission percentages. It will also track two vendors and store on-order data, order quantities and due dates for each.

Although it has a 20-character item number which uses letters and numbers, it does not have a description field, however it does allow for returns and adjustments as well as sales and receipts in its transaction routine. It

(Continued on page 34)

FIELDS TABLE

	Item ID #	Description	Product Code	Vendor Name	Vendor #	Last Cost	Average Cost	Prices	Reorder Level	Reorder Quantity	Reorder Report Date	YTD Sales	PTD Sales	YTD Cost	PTD Cost	YTD Units Sold	PTD Units Sold	Quantity on Hand	Quantity Ordered	Total Cost	Department Sort	Date Ordered	Date Due	Quantity Backordered	Location/Bin	Margin: $ or %	Replacement Cost	Last Sale Date
Peachtree	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■								
BPI Systems[1]	■	■			■	■		■	■							■	■	■	■	■								
SSG, Inc.	■	■			■	■		■	■	■		■	■	■	■	■	■	■				■	■	■				
TBS[1]	■	■			■	■		■	■	■		■	■	■	■	■	■								■			
Radio Shack	■	■	■		■	■		■								■	■	■	■	■						■		
Galactic[2]	■	■	■	■	■	■		■	■	■		■	■	■	■	■	■		■							■		
Custom Tailored	■	■			■	■		■		■							■	■		■								
COMPAL[3]	■	■		■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	■	
Serendipity	■	■	■		■	■		■	■	■		■	■	■	■			■	■							■		
B.E.C.	■	■			■			■	■	■						■	■	■	■			■		■	■			
COMPUMAX[4]	■	■		■		■	■	■	■							■		■	■				■					
Computer Place	■	■	■		■	■		■	■	■		■		■		■		■	■									■
Micro Architect	■	■			■	■		■	■			■		■		■		■	■						■	■		
DBIS	■	■			■	■		■	■	■		■		■		■												
CMS Software	■	■			■	■		■	■	■		■	■	■	■	■	■	■	■						■			
Micro Computer Industries	■	■				■		■				■		■		■												

20 Questions To Ask About Inventory Software

Buying inventory software will be one of your most important and most difficult decisions. Arm yourself with the specific questions below before asking a dealer about the performance of his inventory packages. If you plan to buy through mail order, send for a brochure first, and check to make sure it answers all your questions. If it doesn't, as it most likely won't, call the software house and get your questions answered.

Because each business is different, these questions should be considered a starting point. Add your unique considerations to them before you shop.

(These questions were prepared with the help of Ron Wong of AMD Consulting, Ltd., New York, N.Y., and Ron Sawyer of Lifeboat Associates, New York, N.Y.)

1. What type of inventory system do I need?
   a. Finished goods
   b. Raw materials
   c. Retail
   d. Pseudo-retail—buy and sell only
   e. Multiple systems, including bills of materials

2. How are the system's item number codes derived? Does it differ substantially from your existing numbering system?

3. How many characters does the program allow for descriptions? (The more the better.)

4. Can it handle more than one price per item?

5. Does it allow you to include more than one vendor and one cost per item? If not, how does the system handle more than one vendor per item?

6. Will it allow for returns and adjustments to inventory?

7. How many inventory periods does it provide? Month- and Year-to-Date only? Multiple periods?

8. How quickly can you query a single item, and how? Do you query by description, item number or vendor; by two of those, or by all three?

9. Does it integrate with a General Ledger package? Accounts Receivable? Accounts Payable? Job Costing? Order Entry?

10. How much storage capacity do you reasonably need? (Ignore the minimum system because it will rarely hold enough records to accommodate your system.)

11. How many files can be written to each disk?

12. What reports and lists does the package provide?
   a. Master (or Stock) List
   b. Price List
   c. Back Order Report
   d. Order Report
   e. Departmental Summary
   f. Reorder Report
   g. End-of-Month or End-or-Period Report
   h. End-of-Year Report
   i. Physical Inventory Worksheet
   j. Transaction Control or Audit Trail List
   k. Inventory Turnover Report
   l. Inventory Skrinkage/Overage Report
   m. Items On Order Report
   n. Returns and Adjustment Report
   o. Back Ordered Items Received Report

13. Does the program describe quantities *committed*, but not shipped in addition to items on hand and on order?

14. How does the package measure quantities? By unit or by measurement, such as dozens, quarts, ounces, gross, etc.?

15. Does the package provide for identifying inventory by warehouse or bin location?

16. What costing method do you need and what does the package provide?
   a. Average
   b. Weighted average
   c. Standard cost
   d. LIFO (Last In, First Out)
   e. FIFO (First In, First Out)
   f. Multiple methods

17. Do your sales consist of cash and billing? Or only one way? How does the package handle them?

18. How does the package help you identify slow-moving items?

19. How does the package carry out sort and search functions? How many sorts and searches does it allow?

20. How long has the package been available? How many companies have used it and for how long? What was the background of the programmer(s) who wrote the program?

comes with three exceptional reports: receipt of backordered items (which helps a user quickly fill backorders); an item-usage report with six reporting periods; and a physical inventory adjustment report.

You can also select ranges or product classes you want to print in the item usage report. The same report highlights items that fall below minimum levels. The inventory adjustments report shows the differences between the book and actual count in quantity and dollar value terms.

Serendipity Systems, Inc. offers three different inventory programs, including a 48K RAM system for the Apple II Plus which is a subset of the two larger packages. The small package uses an 80-column printer and a 40-column screen that wraps the other 40 columns. Its maximum capacity is 1,200 items for one drive, and 2,800 items for two drives. It makes the best use of the Apple II by dividing the items into files of 200 records each. An entire file is loaded at a time, so a user can access any record in one second. Each record is limited to 64 bytes and includes a part number, description field, stock level, on-order and on-hand quantities, and month-to-date and year-to-date sales.

The company's two large packages include a 48K version in either CBASIC with a CP/M operating system or Cromemco BASIC, and a 64K version in Cromemco BASIC only. They can handle up to 20,000 items, any of which can be accessed with "hasing" algorithms in less than three seconds. The largest system is for a manufacturer's inventory and includes a complete bill-of materials capability and lead time factors that are essential to a manufacturer.

B.E.C. (Business Enhancements Compuservice) offers an inventory package that is supported by the 32K Commodore CBM with the 8050, one-megabyte disk drive. The system will handle up to 1,100 items per disk. It produces seven standard reports, and has one exceptional feature: it runs an old part number and new part number and correlates the two so you can sort on the new part number. It breaks the inventory down into four categories and provides subtotals according to those categories. And the user can define what each category stands for—department, product class, etc. It also provides a bin location field. The record's fields also include a description, a model number (vendor's number), minimum and maximum on hand, three price choices and more. You can sort and print by groups of part numbers, but its sorting function is limited to part numbers. It, too, offers a very good, one-year warranty on all coding "bugs."

COMPUMAX's *MICROINV* package is available for more types of computers than any other. (See Vendor Guide.) Aimed at small manufacturers, the program offers all standard reports and functions, but adds a Job Costing Report/Materials that allocates the cost of materials to different jobs. It can be used with the company's Job Cost Report/Labor in its *MICROPERS* package, a payroll and personnel management system. It also has an economic order quantities program that produces a report listing recommended purchase quantities. Its master record has a large 30-character description field, uses LIFO costing method, includes lead time for orders, provides ABC class analysis, a safety stock point, expected delivery date, and four job cost categories.

The Computer Place provides inventory software for 48K RAM NorthStar computer systems. It requires two mini-floppy drives and will store up to 1,800 items per data disk (of course, one disk holds the program). Aimed at small manufacturers, it has a modified job costing function and report. Its exceptional features include four vendor fields, 10 part codes, and five classifications. It also includes the date of last sale, which will help identify slow-moving items. This package has been used mostly by construction companies and small manufacturers, a company spokesman said.

Micro Architect's *INV-M2* system, for the TRS-80 Model II, generates an order report indicating safety stock levels, a performance report, a management report giving a summary of all activity, a data base list and an end-of-year processor. A search command allows any record to be searched according to several fields. *Version 5* of this package has just been released, and a CP/M version is in the works. The system also includes a report writer with which you can specify up to 10 formats and produce a very specialized look at these categories. For example, you can look at all items with 10 or more units in stock that cost between $10 and $20 and were purchased by a specific vendor. This report writer is a useful and powerful feature. Unfortunately, the manual is poorly written and difficult to understand.

CMS Software Systems produces an inventory control system for the 32K Commodore CBM series. Using a 2040 disk drive, it will store up to 1,250 items per disk. It will track sales figures by manufacturers, figure the standard margin, generate a physical inventory worksheet by location, and produce over- and under-stock reports. The company claims its random access file structure will display any record within one second.

Micro Computer Industries, Ltd.'s, *Inventory Control* package is designed for the 32K Commodore PET or CBM machine and will store at least 2,000 items per mini-floppy disk drive. It also acts as point-of-sale and accounts receivable programs. It will write invoices, keep sales tax totals, update cash and credit sales, maintain charged items records, payment on accounts, and will also print bills and print out summary reports.

DBIS (Designers and Builders of Information Systems) provides a wholesale industry distribution system, including inventory control, order entry/invoicing and accounts receivable for large Ohio Scientific C3-series computers. It automatically adjusts perpetual inventory and accounts receivable when a new invoice is produced. Reports for inventory include selected items, wholesale cost report, retail price list, or both of the latter. You can make queries by product number or over a range of product numbers. DBIS' business information system (*BIS*) packages require an OSI C2 or C3 computer with 48K RAM, single- or double-sided dual floppy disk drives, a Hazeltine terminal, an RS-232 serial printer, the OS-65U operating system, or a Centronics-compatible parallel printer.

Conclusion

It's clear from this detailed examination that no perfect inventory control system exists. You will have to thoroughly study your business to determine what kind of inventory system you need. Take heart, however, because once your package is installed, you will begin to discover new ways to make new profits without increasing your expenses. □

VENDOR GUIDE

COMPANY	SYSTEM REQUIRED	PRICE
American Business Systems, Inc. 439 Littleton Rd. Westford, MA 01886 (617) 486-3509 *Circle No. 162*	TRS-80 Model II 64K Two 8-inch disk drives 132-column printer CP/M or Oasis Operating Systems Multiple versions	$750 depends on dealer
B.E.C. Business Enhancement Compuservice 1171 E. Valley Pky. Escondido, CA 92027 (714) 741-6335 *Circle No. 163*	32K Commodore CBM 8050 megabyte drive 8020 printer	$150 $170 ROM chip
BPI SYSTEMS (distributed by Apple) 1600 W. 38th St. Suite 444 Austin, TX 78731 (512) 454-2801 *Circle No. 156*	Apple II, Apple II Plus Applesoft or Language Card (not required with II Plus) 48K RAM, 2 disk drives, 80-column line printer	$395
CMS Software 5115 Menefee Dr. Dallas, TX 75227 (214) 381-0690 *Circle No. 170*	Commodore CBM 32 K RAM 2040 Disk Drive	$400 (approx.)
COMPAL Computer Systems, Inc. 6300 Varial Ave. Woodland Hills, CA 91367 (213) 992-4425 *Circle No. 167*	56K RAM Dual drives with 630 K memory 12-in. hi-res monitor High-speed printer Works on Compal 800 or any CP/M system	$500
COMPUMAX Associates P.O. Box 1139 Palo Alto, CA 94301 (415) 321-2881 *Circle No. 165*	Versions for: Apple II 48K PET DOS 2.X; Atari; Microsoft CP/M-CBASIC; TRS-80 Model I and II; Sorcerer; Superbrain; Vector Graphic Micropolis; Dynabyte; Cromemco	$100 for Model I $200 for CP/M $140 for rest
The Computer Place 2718 Colonial Avenue, S.W. Roanoke, VA 24015 (703) 982-3661 *Circle No. 168*	North Star 48K Two double density minifloppies, or 18-megabyte hard disk	$200
Custom Tailored Software, Inc. 93 Old Homestead Road Wayne, NY 07470 (201) 678-7500 *Circle No. 166*	TRS-80 Model I and OSI C3C versions Model I being modified	$495 for Model I Ask for OSI price
DBIS One Mayfair Rd. Eastchester, NY 10707 (914) 779-5292 *Circle No 164*	OSI C2 or C3 48K RAM Two 8-in. drives Hazeltine 1420 or 1500 CRT RS-232 serial printer, or Centronics parallel printer with OS-65-U operating system	$800
Galactic Software 115 N. Port Washington Rd. Mequon, WI 53092 (414) 241-8030 *Circle No. 157*	TRS-80 Model I or III 48K RAM, 2 to 4 disk drives, 132-column line printer	$159/Model I $295/Model III $20/Manual
Hayden Book Co. 50 Essex St. Rochelle Park, NJ 07662 *Circle No. 173*	Apple II, Apple II Plus with Applesoft in ROM, one to six disk drives, 48K RAM	$175
Micro Architect, Inc. INV-M2 96 Dothan St. Arlington, MA 02174 (617) 643-4713 *Circle No. 171*	TRS-80 Model I TRS-80 Model II Health (HDOS and MBASIC) Line Printer	$99 $149 $99
Micro Computer Industries, Inc 1520 E. Mulberry Suite 170 Ft. Collins, CO 80524 (303) 221-1955 (303) 221-1955 *Circle No. 169*	CBM or PET 32 K RAM Two minifloppies, 2040, 40401 8050 CBM or Tally Printers	$200
Peachtree Software Retail Sciences Atlanta, GA (404) 325-8533 *Circle No. 155*	Apple II, Apple II Plus Z-80 Card, Language Card (not required with II Plus), Disk BASIC, CP/M operating system 2 drives, 132-column line printer	$300 to $400 depending upon the dealer
Radio Shack 1300 One Tandy Center Ft. Worth, TX 76102 (817) 390-3272 *Circle No. 159*	TRS-80 Model II, 64K RAM, 132-column line printer single, 8-in. disk	$199 (may vary)
Serendipity Systems 225 Elmira Rd. Ithaca, NY 15850 (607) 277-4889 *Circle No. 161*	Three versions: Apple II 48K RAM, two disk drives 80 column printer; 48 K program with CBASIC II and CP/M operating system OR Cromemco 16K Basic; and Cromemco 16K BASIC 48 K program for manufacturers	$169 $795 $795
Software Technology P.O. Box 428 Belmont, MA 02178 *Circle No. 172*	Apple II Plus 48K RAM Two disk drives 132 column printer	$140 with manual
Structured Systems Group 5204 Claremont Oakland, CA 94618 (415) 547-1567 *Circle No. 158*	8080 or Z-80 based machines 52K RAM, 2 drives with CP/M operating system 132-column printer, CRT with direct addressing (24x80), up to 4 disks	$1,250 (approx.) depending upon dealer/support services selected $25/Manual
TBS The Bottom Shelf P.O. Box 49104 Atlanta, GA 30359 (404) 296-2003 *Circle No. 160*	TRS-80 Model II, 64 K RAM, 4 disk drives, 132-column line printer	$850

OTHER COMPANIES THAT OFFER INVENTORY PROGRAMS

Business-Ware
6640 Elk Park Court
Alexandria, VA 22310

H&H Associates, Inc.
P.O. Box 2663
Renton, WA 98055

S&M Systems, Inc.
P.O. Box 1225
2 Washington Street
Haverhill, MA 01830

Taranto & Associates
P.O. Box 6073
San Rafael, CA 94903
(TRS-80 Model I, II and III)

Computer Marketing Corp. (for Intertec SuperBrain)
116 South Missions Street
Wenatchee, WA 98801

Graham-Dorian Software Systems, Inc.
211 North Broadway
Wichita, KS 67202

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Play the Software GAME

SARGON II (Spracklen) The Champ of champs. "...an excellent program which will provide a true challenge for many players... Save your money and buy SARGON II..." '80 Software Critique. *03403, TRS-80 Level II; 03404, Apple II; 03410, OSI C1P; 03420, OSI C2P; 03440, OSI C4P; 03401, PET; each tape $29.95. 03408, TRS-80 Level II Disk; 03409, Apple II Disk; 03414, OSI C1P Disk; 03424, OSI C2P Disk; 03444, OSI C4P Disk; 03484, C8P Disk; each $34.95*

BLACKJACK MASTER: A Simulator/Tutor/Game (Wazaney) A serious game that performs complex simulations and evaluations of playing and betting strategies. *05303, TRS-80 Level II tape, $24.95; 05308, TRS-80 Disk Version, $29.95*

MICROSAIL (Johnson) A true test of your nautical skills as you race against wind, tides, and time. *04401, PET tape, $11.95*

GRIDIRON: A Microfootball Game (Microflair Associates) Be both offensive and defensive quarterbacks. Includes time-outs, penalties, and the two-point conversion option used in college football. *03003, TRS-80 Level II tape, $12.95*

MAYDAY (Breitenbach) Out of fuel! Try to avoid crashing with this challenging airplane flight simulation. *02601, PET tape, $9.95*

REVERSAL (Spracklen) *Winner* of the software division of the *First International Man-Machine OTHELLO™ Tournament*, this version of the 200-year old game Reversi, features 27 levels of play and high-resolution color graphics. *07004, APPLE II tape, $29.95; 07009, APPLE II Disk, $34.95*

STARCLASH (Walton) An exciting game of galactic strategy for one or two players. *05903, TRS-80 Level II tape, $16.95*

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6502 DISASSEMBLER (Stamm) Produce assembly language source files with labeled subroutines and references from programs already in memory. It is compatible with Hayden's ASSEMBLY LANGUAGE DEVELOPMENT SYSTEM. *08609, APPLE II Disk, $34.95*

DISK CERTIFIER AND COPIER (Jacc Inc.) A handy utility program that certifies the acceptability of blank diskettes and rejects those with flaws. It also includes a fast machine language disk copying program that will work on single and dual drive systems. *07809, APPLE II Disk, $19.95*

DISK CATALOGER (LeBar) Automatically maintains a cross-reference listing of all your programs, their location by disk number, their function and use. Catalogs, lists and sorts programs. *05203, TRS-80 Level II tape, $16.95; 05208, TRS-80 Level II Disk, $21.95*

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MAILING LIST (Tru-Data Software) Lists addresses, prints labels, allows for alterations and deletions, and has the capacity to make duplicate data file disks. Can only be used with version 1.5. *05713, Heath Disk, $49.95*

ENGINEERING Software Designs

MCAP: A Microcomputer Circuit Analysis Program (Savon) Performs a linear voltage, impedance, or transfer impedance analysis of an electronic circuit. *04501, PET; 04503, TRS-80 Level II; 04504, Apple II; each tape $24.95; 04513, Heathkit/Zenith Disk, $29.95*

ENGINEERING MATHEMATICS-1 (Gilder) Contains eight programs useful to the engineer: 1. Solving Simultaneous Equations 2. Evaluation of a Polynomial 3. Quadratic Equations 4. Integration by Simpson's Rule 5. Newton-Raphson Roots 6. Derivative of a Function 7. Factorial of a Given Number 8. Extended Factorial Calculation. *01301, PET; 01303, TRS-80 Level II; 01304, Apple II; each tape $14.95*

MICROCOMPUTER AIDED DESIGN OF ACTIVE FILTERS (Gilder) Eight programs that simplify the design of active filters and will calculate the component values needed for various bandpass, low-pass, and notch-type filters. *01401, PET; 01403, TRS-80 Level II; 01404, Apple II; 01407, Heath; each tape $16.95; 01413, Heathkit/Zenith Disk Version, $21.95*

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THE FIRST BOOK OF KIM, 3 Tapes (Butterfield, Ockers, and Rehnke) Three cassettes featuring 28 recreational and 13 utility and diagnostic programs. *00700, KIM-1* (14 recreational programs); *00800, KIM-1* (14 recreational programs); *00900, KIM-1* (13 utility programs); *each tape $9.95*

MICROTYPING (Engel) Features the "touch method" of learning to type for improving your computer skills. *02401, PET; 02403, TRS-80 Level II; 02404, Apple II; each tape $10.95*

COMPLEX MATHEMATICS (Gilder) Contains 8 programs that give the user the ability to perform computations of complex numbers in BASIC rather than in FORTRAN. The eight programs are: 1. Absolute Value 2. Complex Addition 3. Complex Subtraction 4. Complex Multiplication 5. Complex Division 6. Nth Roots of a Complex Number 7. Complex Exponential 8. Complex Number to a Real Power. *01201, PET; 01203, TRS-80 Level II; 01204, Apple II; each tape $14.95*

GENERAL MATHEMATICS-1 (Gilder) Contains 15 programs useful to anyone who wants to improve their math skills and accelerate their computation. The fifteen programs are: 1. Log to Any Base 2. New Coordinates 3. Rectangular/Polar Coordinates 4. Permutations 5. Combinations 6. Vector Cross-Products 7. Vector Scalar Products 8. Max/Min Locator 9. Number Rounder 10. Dimension Scaler 11. Histogram 12. Circle Finder 13. Nth Root of a Number 14. Normally Distributed Random Numbers 15. Rational Fractions. *01101, PET; 01103, TRS-80 Level II; 01104, Apple II; 01105, Sorcerer; each tape $14.95*

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ENERGY MISER (SuperSoft Associates) A complete heating/cooling analysis program for your home or office that will calculate heat loss or gain due to poor insulation, leaky doors and windows, and more. *05601, PET; 05603, TRS-80 Level II; 05604, Apple II; each tape $24.95; 05609, Apple II Disk Version; 05613, Heathkit/Zenith Disk Version; $29.95*

PERSONAL PROPERTY INVENTORY (Southern Systems) Here's an easy-to-use program that lets you develop, maintain, sort and save an inventory of your personal property. *08903, TRS-80 Level II, tape, $14.95*

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KEYNOTE (Microflair Associates) Hear any type of music in slow, medium, or fast tempo. *02903, TRS-80 Level II tape, $9.95*

BIOCURVE (Microflair Associates) Charts your biorhythms against another person's and suggests when you will be in a state of instability and therefore vulnerability. *03103, TRS-80 Level II tape, $9.95*

HOW TO BUILD A COMPUTER-CONTROLLED ROBOT (Loofbourrow) Contains 5 control programs that consist of: Joystick Control Program; Self-Direction Program; Impact Sensor Control Routine; and more. *00100, KIM-1 tape, $14.95* Should be used with text **HOW TO BUILD A COMPUTER-CONTROLLED ROBOT,** *5681-8, $9.75*

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CIRCLE 13

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Software Review

Standard & Poor's STOCKPAK

BY ALAN M. BOYD

Personal computers have served as investment aids since their advent a few years ago, but until recently, users had to be able to program them themselves if they wanted them to aid in any task other than routine bookkeeping. Now, however, the availability of investment aid software means that the investor can use the power of these small, inexpensive machines to handle all of the tedious details involved in the management of a securities portfolio.

Programs are now available that help the active investor keep financial records and calculate earnings, weights, ratios and other such numbers automatically. The advantages of using these programs are that investors have a broader base, with less effort, for making complex financial decisions, and busy portfolio managers can produce sophisticated reports for their clients by pushing a few keys on a personal computer.

In the past, many small investment firms have produced software, primarily for use in-house, to aid in this process. Now, however, the "big guns" of Wall Street, seeing that they have to act now or be left at the starting gate, are getting into the act. Those companies who make their livings by marketing data are now surfacing in the personal computer industry, notably Dow Jones, and now Standard & Poor's.

One of the results of Wall Street's love affair with the personal computer is the STOCKPAK, a joint effort by Standard & Poor's Corporation and Radio Shack. STOCKPAK is a set of programs for the Radio Shack TRS-80 Level II 32K Business System that has been designed by the backroom boys at Standard & Poor's Corporation for use in securities portfolio management and stock evaluation. In actual fact, the system is composed of two distinct products: First, there is the STOCKPAK, which, although designed by S & P, is available through Radio Shack. The other product is a subscription system, whereby STOCKPAK owners can obtain monthly updated of the S & P data base on diskette.

Disk #1

STOCKPAK is a set of four diskettes and a substantial documentation manual packaged in Radio Shack's traditional three-ring binder. Disk #1 is the Portfolio Management System, which can be used to maintain a portfolio of up to one hundred securities, with as many as thirty transactions on each issue. Computer-management of a stock portfolio, for those who are not familiar with the concept, is a very powerful instrument utilized for simulation and strategic planning. As well as keeping track of real portfolio data, the computer can also be used to store recommendations from a broker, or some other source of information. This makes it possible to store your broker's advice, along with the price and date of the recommendation, for future reference. Undoubtedly, this is a highly effective method of evaluating their performance.

This program keeps track of all Buys, Sells, Stock Split and Dividends affecting the portfolio and handles all of the arithmetic required to evaluate the holdings. Mercifully, this Portfolio Manager also handles Commissions, an adjustment overlooked by many systems currently available. On-screen and hard copy reports can be generated to show the current status of each security, net position, long and short-term gains and losses, profit summaries, dividends received, rate of return analysis and eligibility for long-term gains or losses for tax considerations.

Disk #2

The second disk in the set contains the Screen and Select System. This disk contains the software that permits you to apply a variety of investment criteria to the 900-stock S & P data base, which is purchased separately on a subscriber basis. This program is actually a vertical application of data base management, specifically designed for stock selection. When first purchased, this system holds a number of predefined selection criteria.

For example, one set of selection criteria can be set up to select every stock in the data base that has a Price/Earnings ratio of less than or equal to six, and a yield greater than or equal to six. Ten ready-to-use sets of selection criteria have been included, and you have the ability to set up your own sets based on any of the thirty financial facts on each of the 900 stocks available in the data base. These selection criteria are

set up using an easy to follow, yet powerful system of definitions known as the Data Dictionary.

Data Dictionary

Using the Data Dictionary, you may define a new element of the data base by combining other elements in some sort of logical or calculated fashion. For example, if you subscribe to an investment strategy that uses a ratio such as Debt/Working Capital as an indication of risk, you may define this ratio as an element of the Data Dictionary. Then this element may be used as a criteria for selection. Once a Data Dictionary element has been defined, it is automatically maintained and need never be re-defined. In this manner, you may tailor your selection criteria to your particular investment strategy, no matter how unusual it is!

One of the nicer features of the system is the ability to update the portfolio automatically using the subscriber data base. When the disk is received, there is a feature by which any securities held in the portfolio can be updated by the more recent data. Another interesting feature available is the News Retrieval System. The data base disk contains a synopsis of recent financial news and trends which have occurred since the last disk was mailed. This news can be printed on the screen, or on a printer, as desired. One other notable feature is the ability to create a spinoff file (on disk) of the results of any selection scan. This lets you run a selection of stocks against a set of criteria and then save the results to disk for processing or retrieval at some later date.

Disk #3

The third disk in the system is called the Report Writer and, as its name implies, it contains software that allows the creation of custom reports on stocks that pass the selection criteria, along with any information available on the data base for those stocks. Reports can be generated on the screen or on a printer. Thoughtfully, S & P have included a set of ten ready-made screen formats and twenty printer report formats based on professional strategies currently used in the financial community.

Disk #4

The fourth disk is actually a sample of the S & P data base available directly from S & P for an annual subscription of $200. This data base consists of thirty financial facts on about 900 of the most actively traded New York, American Exchange and over-the-counter common stocks, and is mailed to subscribers on a monthly basis. This service is what makes this package *different* from other portfolio management and evaluation systems. If your portfolio consists of stocks listed in the data base, then you can have your portfolio updated automatically every month. Since the data base consists of the 900 most actively traded stocks, there is at least a fair chance that a large part of your portfolio can be managed without you getting too involved. Also shipped with the diskette is a copy of the S & P Stock Guide, a notoriously handy 256-page listing of pertinent financial data on more than 5100 common and preferred stocks and over 380 mutual fund issues. The financial "facts" available on the 900 companies are extensive and include all of the pertinent information that should be required to evaluate both long and short-term potential of the 900 companies. They are:

General

Ticker Symbol
Industry Classification
Exchange on which traded
S & P Earning and Dividend Rank

Earnings Per Share

Three Years EPS
Estimated EPS
EPS last 12 months
Five-year EPS Growth Rate
EPS Footnote

Net Sales and Net Income

Net Sales (latest available)
Net Income/Loss (latest available)
% Change Sales (% change between last two years)
% Change Net Income (% change between last two years)
Fiscal Year End

Prices

Current Price (Month End)
Prior Year End Price
High Price to Date
Low Price to Date

Balance Sheet

Cash & Equivalent
Current Assets
Current Liabilities
Long Term Debt
Common Shares Outstanding
Book Value per Share
Balance Sheet Date

Miscellaneous

Ex-Dividend Date
Current Indicated Dividend Rate
Previous Month's Traded Volume

Well worth the money

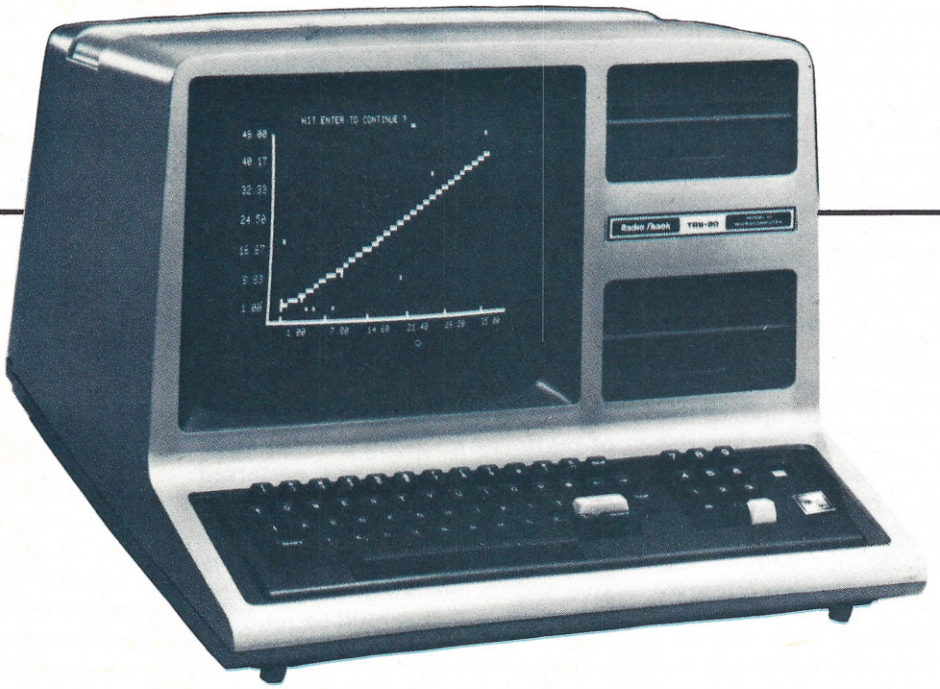
In all, the STOCKPAK as a stand-alone product, seems well worth the $49.95 price tag, but it should be realized that to reap all of the benefits from the package you also need the $200 per year subscription to the S & P data base. For those who are seriously involved in managing portfolios, this would appear to be well worth the price. The system is professionally executed, as one would expect a product from this institution to be.

The only bone that is to be picked concerns the speed at which certain parts of the program run. Principally the screening of the STOCKPAK data base is slow, requiring around 20-30 minutes to screen the entire data base of 900 stocks against a set of selection criteria. However this seems a mere drop in the bucket when compared to the time required for the U.S. Postal Service to deliver the data disk.

Overall, however, the system is extremely powerful and open to all sorts of customization. As a first venture into the world of personal computers, S & P have shown that they are heading in the right direction. In naming their data base "Series 1," it appears that S & P has other ideas for follow-up products to make personal computers more useful to investors, so we'll keep our eyes peeled for them. □

Inside The Model III

BY RALPH BURRIS



By now you have probably read a lot about the TRS-80 Model III. In fact, you may have seen one or, if you are lucky, you may have even have one of your own. If you fall into the latter category, we will get to you in awhile, but for the time being, I want to give everybody else a chance to have a look for themselves.

Model I Grows Up

The Model III is a logical and seemingly well-planned enhancement to our trusty Model I, although it will suffer some of the familiar "growing pains" we have all experienced while breaking in the Model I design. The most obvious difference in the new system is Radio Shack's abandonment of the "modular" design—that is, the Model III is self-contained in one case, and upgrades to the system (up to two disk drives and 48K of RAM) require no additional external cases. Two more disk drives and printers, modems and so forth, are the only external peripherals you have to find space for.

The initial package provides a bunch of goodies that required modifications in the Model I, such as a numeric keypad and lowercase (with driver software). Sockets for RAM expansion up to the full 48K, as well as the connector for the RS232 serial port, are provided. Adding disk drives to the unit is a simple (if somewhat costly) task. The disk system is set up in a double-density configuration, which means, in effect, that each drive has the storage of two drives on the Model I.

The CRT in the Model III is a high-quality monitor, which provides a sharp image for the new character set allowing much greater contrast and brightness adjustment than the TV set that came with our Model I. Another enhancement of the video processing is a new line in the processor that prevents access to the video RAM by the system except during the horizontal blanking, or re-trace phase, of the CRT scan. This means that you get a clean video picture at all times—free of the familiar "glitches" on the Model I screen. It also means that anything using video output will run a bit slower, but it is a good trade-off. To test this out, try running a program with a lot of graphics, such as Radio Shack's "Dancing Demon." When run at a fast speed on the Model I, the Demon breaks up into a hash of lines on the screen as the refresh, image output, and all that, fight for time in the video memory. On the Model III, the same program will show a smooth white image, with no "hashing" of the picture, even though it runs slower.

Improved Character Set

The new character set in this computer is a beauty. The characters are a new size (8 X 12, vs. the Model I's 6 X 12) and offer the full

96 ASCII values (upper and lower), directly from the keyboard in "shift lock" or upper/lower case model. Model III also gives you the same graphics set as Model I. The exciting new feature of the character set is the addition of 64 "special characters," including such goodies as faces, pips for playing cards (a set of three which make up a hand pointing to the right), prescription ("Rx") symbol, and others. These characters are interchangeable with the "compression" tokens (values from 192 to 255) via software. Also, 64 special characters have an alternate set of Japanese Kana characters which can be swapped via software switches. All of these characters can be utilized in programs with BASIC's PRINT or POKE statements. There are 32 additional characters available using the POKE statement, occupying the values from 0 to 31, which are interpreted as ASCII control codes if used in a PRINT statement.

Model III allows you to write programs using the upper/lower case mode and automatically converts command statements to all upper case. This is a nifty feature to those of us who are accustomed to the upper-case only model.

Other Added Features

Taking their cue from three years of testing the Model I, Radio Shack has included some of the better features that have been introduced, often by "outside" sources. Most notably, the Model III provides the ability to print the contents of the screen to the line printer by pressing a combination of keys (more on this later).

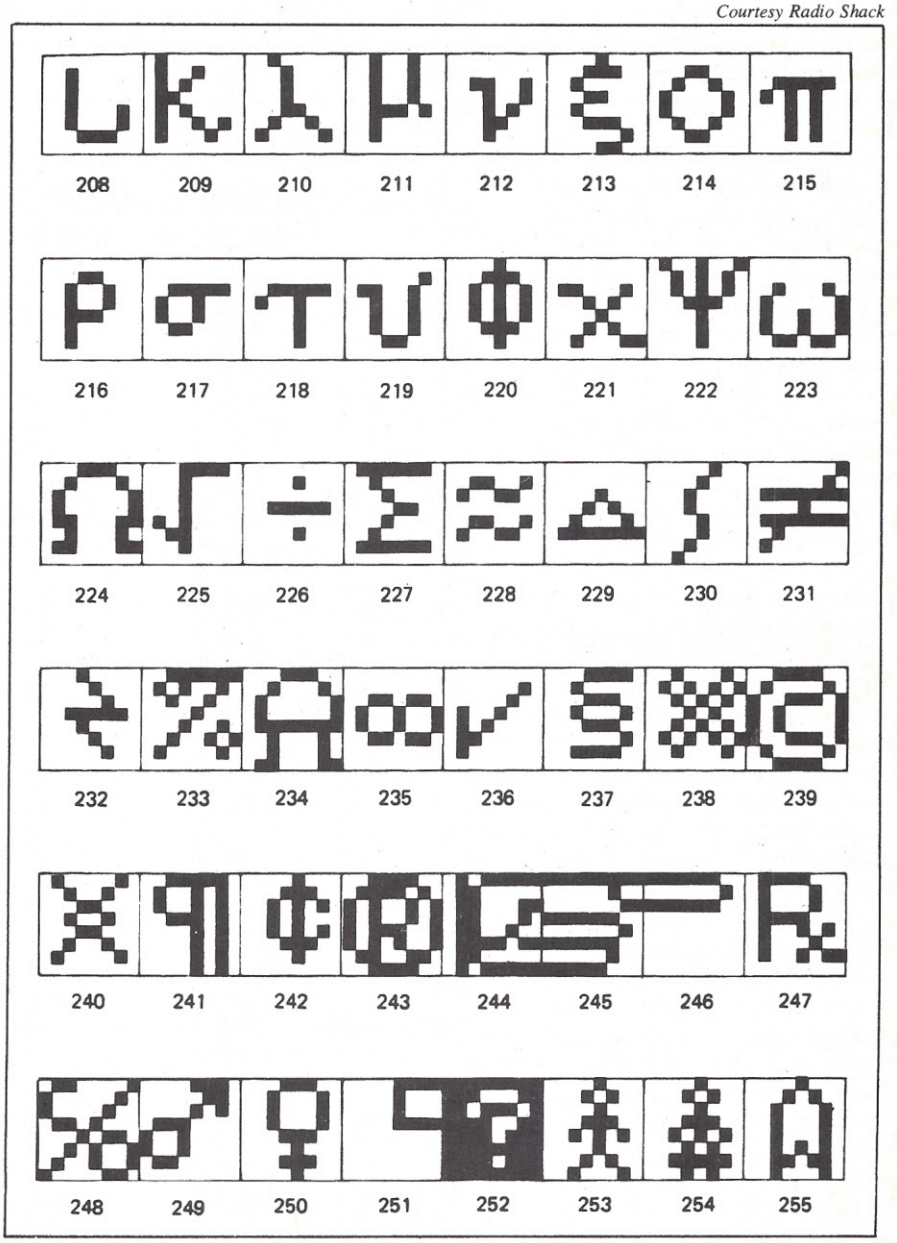
Model III BASIC is essentially the same as Model I's Level II with one additional command, TIME$, which is familiar to Disk BASIC users. TIME$ returns the current date and time (set via POKE), in the MM/DD/YY HH/MM/SS format. The fact that the Model III can keep track of time means there is a clock routine in there somewhere. If you have used Model I's Disk BASIC, you are painfully aware that the clock must be turned off (CMD"T") during cassette operations, to prevent a nasty interrupt pulse from interfering with your valuable data. Model III takes care of this problem automatically, so you hardly notice the clock at all (unless you run a music program or machine language programs that were designed for the Model I). A case in point is the "Electric Pencil" (tape version), which runs fine on the Model III until you try to do some tape I/O. The Pencil, as well as the rest of our favorite Model I software, relies on the Z-80's "DI" (disable interrupts) statement to turn off the clock, which is under software control.

The Model III, on the other hand, incorporates a hardware interrupt for clock control and is not affected by the "DI" statement. The presence of the clock is more evident in music programs, because of the annoying "click" during the notes. Fortunately, there is a fix for this problem. The clock can be shut off by sending zero to port EON (224 dec). This can be done from BASIC by issuing the statement "OUT 224,0" (either from Command level or in a program), and in assembly programs by XOR A (makes the accumulator equal to zero), followed by OUT (OEON),A.

The Model III has another unique feature usually found on "smart" terminals—the ability to protect up to seven lines at the top of the monitor. This is a handy method of keeping some information on the screen at all times, while the rest of the screen is scrolling text or displaying other information.

Some other interesting design changes have been incorporated internally, further indicating a matur-

Courtesy Radio Shack



Sixty-four interchangeable characters make up a new feature of the Model III.

ing of the product. The parallel I/O port (Centronics-type) is a full 8-bit line, where the Model I supported only 4 bits. This means that "smarter" peripheral devices may be attached to the Model III. Your old parallel printer will work just fine, however, as the only physical difference in the hook-up is a smaller opening in the case for the edge-connector. Screen memory also provides the full 8 bits, allowing display of any character, where the original (unmodified) Model I had a 7-bit memory block, which tied two bits together and changed most data stored in it.

Speaking of ports, the Model III is much more of a port-oriented system than the Model I was, in that the lineprinter and disk drives are accessed through ports rather than being tied to memory addresses. This causes a small amount of software compatibility problems in some machine language programs when it comes to lineprinter (and disk) operations. Some effort to keep the same scheme was retained—the status of the lineprinter may still be tested at 37E8h (or from port F8h), but characters must be sent to port F8h.

For those of you who are a bit foggy on this port business, you might want to pick up a copy of William Barden's "Z-80 Microcomputer Handbook," for a complete explanation. In a nutshell, the Z-80 can access memory in 8-bit chunks (bytes), or ports in bit-by-bit pieces. There can be 65,536 (64 K) memory locations or ports, accessable to the CPU at any given time.

It is up to the hardware designers to decide whether to use ports or addresses in the system. In computers, data storage is given the highest priority, so less emphasis is placed in ports in favor of memory. In fact, the Model I has only one port—FFh—which is used for cassette operations and screen mode (32 characters per line). The Model III uses the same port for these functions and adds a couple of additional items. In a port operation, the CPU can send or receive information from an external device, but it is up to that device to manipulate the data once it has been sent. In a memory operation, on the other hand, the data can be stored or retrieved by the CPU.

There are a great deal of other enhancements incorporated in the Model III (in fact, I'm quite sure that I haven't even begun to scratch the surface), but the one other thing I'd like to mention is the ability to BREAK out of I/O operations. The Model III BASIC allows you to escape from CSAVE, CLOAD, LLIST and LPRINT by hitting the BREAK key. The inability to escape these functions in the Model I was the cause of more than one agonizing moment for the TRS-80 user, and this in itself makes the whole new machine a joy to use.

Radio Shack Grows Up

There was a considerable amount of brouhaha surrounding the Model I's ROM map in the early days, and Radio Shack made quite a point of secrecy regarding ROM addresses. Having them saves a lot of us many long hours of exploration (and, in fact, provided some folks with a profitable venture in publishing all the "secrets" of BASIC). It appears that Radio Shack has seen its way clear to provide the Model III user with a fairly detailed list of ROM addresses for the most-used functions, as well as a complete description of methods for accessing and using these routines in your own programming efforts.

Model III BASIC appears to have been designed to maintain as much compatability as possible with most Model I machine language software. In fact, most Model I assembly programs will operate normally in a Model III if the programmer used the previously verboten ROM calls for most I/O routines, because the majority of those addresses (for such things as printing text or cassette I/O) have been maintained. This was accomplished by leaving the routine in the same place (i.e., 1A19H is still the reentry point for BASIC) or by replacing the original addresses with vectors to the new routines. Most of the vectors have been located in the area of missing

Courtesy Radio Shack

Code Dec.	Code Hex.	Keyboard	Video Display PRINT CHR$ *(code)*
1	00		No effect
1	01	BREAK SHIFT ↑ A	No effect
2	02	SHIFT ↑ B	No effect
3	03	SHIFT ↑ C	No effect
4	04	SHIFT ↑ D	No effect
5	05	SHIFT ↑ E	No effect
6	06	SHIFT ↑ F	No effect
7	07	SHIFT ↑ G	No effect
8	08	← SHIFT ↑ H	Backspace and erase
9	09	→ SHIFT ↑ I	Tab (0, 8, 16, 24, . . .)
10	0A	↑ SHIFT ↑ J	Move cursor to start of next line and erase line
11	0B	SHIFT ↑ K	No effect
12	0C	SHIFT ↑ L	No effect
13	0D	ENTER SHIFT ↑ M	Move cursor to start of next line and erase line
14	0E	SHIFT ↑ N	Cursor on
15	0F	SHIFT ↑ O	Cursor off
16	10	SHIFT ↑ P	No effect
17	11	SHIFT ↑ Q	No effect
18	12	SHIFT ↑ R	No effect
19	13	SHIFT ↑ S	No effect
20	14	SHIFT ↑ T	No effect
21	15	SHIFT ↑ U	Swap space compression/ special characters
22	16	SHIFT ↑ V	Swap special/alternate characters
23	17	SHIFT ↑ W	Double-size characters
24	18	SHIFT ← SHIFT ↑ X	Backspace without erasing
25	19	SHIFT ↑ Y	Advance cursor
26	1A	SHIFT ↑ Z	Move cursor down
27	1B	SHIFT ↑	Move cursor up
28	1C	SHIFT ↑ .	Move cursor to upper left corner
29	1D	SHIFT ↑ 9	Erase line and start over
30	1E	SHIFT ↑ .	Erase to end of line
31	1F	CLEAR SHIFT ↑ /	Erase to end of display

The Model III contains control characters not available in the early machines.

addresses in the Model I (3000H to 37DDH). Some routines don't work, however (such as some input calls), so caution is advised in using Model I assembly programs on the Model III.

One other problem is that there are 258 less bytes of user available RAM, so programs which try to locate at the absolute beginning of Model I RAM will probably destroy some vectors.

Those Model I programs which have their own character handling routines (i.e., Radio Shack's tape Editor/Assembler), will definitely not work on the Model III, due to timing errors produced by the slightly higher clock rate in the new machine. Apparat's EDTASM package, on the other hand, works fine with Model III's tape I/O because Apparat replaced internal routines in the RS Editor/Assembler with ROM calls. (As mentioned earlier, the clock must be shut off prior to executing these types of programs.)

Memory Map

Decimal Address	Contents	Hexadecimal Address
0	12 K ROM Model III BASIC	0
12288	2 K ROM for System Use	3000
14336	Keyboard Matrix	3800
15360	Memory-Mapped Video Display: Upper left corner = 15360 + 0. Lower right corner = 15360 + 1023.	3C00
16384	Reserved for System Use	4000
17129	User Memory For Program and Data	42E9
32767 49151 65535	"16K RAM" ends here. "32K RAM" ends here. "48K RAM" ends here.	7FFF BFFF FFFF

Here are the important ROM decimal addresses (with hexadecimal addresses shown in the right hand column) for the Model III, as found in the Model III Users' Manual. For those of you who wish to write your own program, this will prove to be an invaluable aid.

Model III is Device-Oriented

As most of you are aware, the TRS-80 systems are "device-oriented." This means that most, if not all, I/O functions are readily interchangeable. A device can be anything from a CRT (monitor screen) to a disk file. Model I users have enjoyed the ability to route the screen to the line printer. The Model III provides a method or routing devices in a simple fashion. You only have to place the device name (KI=keyboard, DO=screen, PR=printer) into an address and set up a ROM call which automatically causes output to the new device. This can be accomplished in BASIC via the USR function, or in machine language with a CALL.

Model III also gives you greater control over the devices. For example, you can set the maximum line length on the printer as well as control the RS232 parameters through similar ROM calls. Cassette baud rate, cursor character, and flash/no flash are also under your control in BASIC or assembly language.

The Bugs

Sadly, as with any new machine, the Model III features the usual menagerie of nasty little bugs. For starters, the initial machines were all delivered with BASIC in PROM (Programmable Read Only Memory) rather than ROM, which means the language was not perfected when the machines were introduced.

Radio Shack explains that some of the features indicated in the User's Manual are not available in the early editions of the Model III, but will be made available at a later date for a slight charge.

Among the features you won't get in an early Model III are the control characters described in the manual as being available from the keyboard with the shift-down arrow. The codes are there and you can use them with BASIC's CHR$ function, but you can't generate most of them from the keyboard. Another annoyance is that the "Screen Print" function is accessed by pressing the "S" and "P" keys rather than using the shift-down arrow ("*" which is described in the manual). This has caused an interesting bug in the Model III. If you are in the EDIT mode and you want to (S)earch for a "P" on the line, the machine sometimes thinks you told it to do a screen print. Unfortunately, there is something else going on in the routine that does not flag this as a screen print, so the end result is a "hang-up." Fortunately, you can escape the problem by tapping the "BREAK" key a few times, which normally has no place in the EDIT mode.

Conclusions

Even considering the problems discussed, I'd still give the Model III a high rating. When your Model I has given up, you have a great machine waiting in the wings. If you are new to the field and want a powerful, reasonably-priced and well-supported computer (and you don't care much about color), the Model III is for you—especially in small (and not so small) business applications.

If you can live with a few temporary bugs, you are probably safe in ordering the Model III right away, but in a few months I'm sure it will be a solid buy. □

MODEL II

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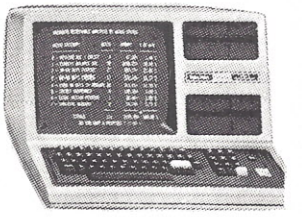
MODEL III



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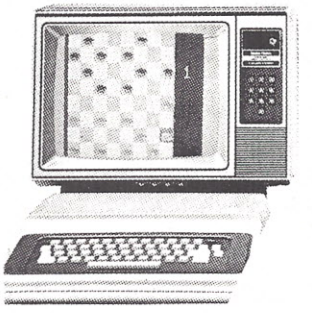

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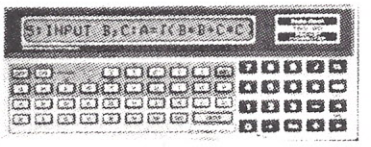

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CIRCLE 14

SECRET MESSAGE CODER/ DECODER

BY W.B. GOLDSMITH, JR.

Once upon a time, the radio serial cereal box top premium was the rage. For twenty-five cents and two box tops from "Crunchie Yuckies" (or some other cereal), you could get a secret decoder ring that carried your favorite cowboy hero's personal cattle brand. It also had a magnifier, a ball point pen that wrote under water and a glow-in-the-dark gizmo. Just about everyone in my grammar school had one, and we sent secret messages that everyone else (except our teachers) could decode.

Radio serials are gone, and the few remaining secret decoder rings command premium prices at the local antique and collectables shop.

A window shopping tour of some collectable shops prompted me to tell my son of the joys of the coder ring. He said that his classmates have computers at home instead of decoder rings. That was it! The coder ring is gone, but we can still enjoy the thrill of our own secret messages. Your personal computer can be "Uncle Bud's Magic Message Coder."

I'm not a cryptographer, so I don't think the codes developed by Secret Message Coder/Decoder will be involved in any secret spy missions, but the codes won't be as easy to break as the daily newspaper version. Like the newspaper puzzle page feature, the program uses an alphabet/symbol substitution. The difference here is that four different codes are used for each message. The four codes are alternated on a letter-by-letter basis throughout the message. Spaces and punctuation marks are coded too. It takes more than a casual glance to decode what appears to be "computer garbage." To prove this to yourself, try to decode the three line secret message to *Personal Computing* readers before you run the program. (Answer on page 108.)

User's Notes

Secret Message Coder/Decoder is easier to use than my old horse opry code ring. (The program neither writes under water nor glows in the dark unless you've got some special peripherals plugged into your computer.) The routine is useful for both coding and decoding, so the first question to appear on your control terminal asks which you wish to do. It's all straight forward from there.

If you're coding a message, the program will either pick a random four-digit number for the code pattern or let you type one in. You can generate a simpler pattern by entering a code number with all digits the same ("3333" or "7777," for example).

With the preliminaries aside, you're ready to start typing your message. Because of a limitation in my version of BASIC (it allows only 32 characters per string variable), the message must be entered in nibbles of 32 characters or less. Subsequent lines in the message will be coded with the same four-digit key. If you've let the computer pick a random code number, it will tell you what was chosen before it prints the code.

Decoding is about the same procedure. For obvious reasons, the computer won't pick a random number for you. You'll have to type in the four-digit key number that goes with the message to unlock the code. (You could break one of these codes with the program even if you lost the key. It would take up to ten runs and some pencil chewin' though. So don't trust your real secrets to the security of this program.) Because the newspaper puzzles generally use a random alphabet substitution, this routine won't be much help in cracking those. Our code sequence is an orderly shift of alphabets—just like the old coder rings.

Programming Notes

Coder is written in SWTP 8K BASIC, Version 2.0. You should be able to use it with other BASICs that have character string and one dimensional matrix handling capability. Other features that may raise questions are:

CHR$ (n) — Specifies a single character equivalent to

the decimal ASCII number value of "n."

STR$ (n) — Specifies the string value of a number. Used to convert numeric variables to string variables.

VAL (n) — The reverse of STR$. Converts string variable numbers to numerics.

ASC (n) —Specifies the decimal ASCII value of a character. This function is the reverse of CHR$.

Most BASICs have these functions, but the command format may vary slightly. I've used the multiple statement per line feature of SWTP BASIC to add REMs to all GOSUB and GOTO statements. If your BASIC doesn't like multiple statements, leave out the REMs. I included them to help readability of the listing.

Because Coder does the same things in a couple of places, it uses a number of subroutines. The main program is housed in statements 100 through 800. The subroutines start at 5000, 6000, 7000, 8000 and 9000. Please refer to the program listing while we stroll through Secret Message Coder/Decoder.

Lines 10 through 80 contain the header and are non-executable REMs. Line 90 includes the variable dimensioning command—vital to program operation. Lines 100 through 140 print the introductory message on your control terminal, while 150 and 160 steer the routine between Coding and Decoding.

Lines 170 and 180 pick the random number. The number must be above 1000 to guarantee four digits (my BASIC suppresses leading zeros). I found it easier to generate the random code key for every program run, then let the user override it with a manual selection in lines 190 through 210. The subroutine at 9000 provides the prompts and error trapping to allow manual entry of the code key number.

Message line input is handled by lines 250, 260 and 270. Subroutine 8000 converts the string variable to a series of ASCII numbers stored in line 8020 then joined to A$ (the message) in line 8030. The combination is limited to 32 places by the FOR/NEXT loop in 8050 through 8070 that stuffs matrix A(x). All of this is because the message variable, A$, will contain fewer than 32 characters if your message is shorter, and the program will round out the total 32 with garbage. Now, the program will round out the 32 with coded spaces which minimizes the confusion when the message is decoded.

Sample Run

```
THIS IS *** COMPUTER CODER ***
YOUR OWN SECRET MESSAGE TOOL.

YOU CAN ENCODE OR DECODE ONE
32 CHARACTER LINE AT A TIME.
WANT TO 'CODE' OR 'DECODE'? CODE
WANT A RANDOM CODE? Y


WHAT LINE DO YOU WANT CODED? PERSONAL COMPUTING IS FUN!

PLEASE STAND BY WHILE I WORK

O.K., I'M READY TO GO AHEAD.

YOUR SECRET CODE NUMBER IS 8034

WHAT PORT FOR OUTPUT? 3

PRESS 'RETURN' TO PRINT?


QGUWPPDP!ERQQWWMOI#MT"IYO##$!"#$
ANOTHER LINE? N

READY
#RUN
THIS IS *** COMPUTER CODER ***
YOUR OWN SECRET MESSAGE TOOL.

YOU CAN ENCODE OR DECODE ONE
32 CHARACTER LINE AT A TIME.
WANT TO 'CODE' OR 'DECODE'? DECODE

TYPE IN THE CODE NUMBER FOR
THIS MESSAGE.? 8034

WHAT LINE DO YOU WANT DECODED? QGUWPPDP!ERQQWWMOI#MT"IYO##$!#$

PLEASE STAND BY WHILE I WORK

O.K., I'M READY TO GO AHEAD.

WHAT PORT FOR OUTPUT? 3

PRESS 'RETURN' TO PRINT?

PERSONAL COMPUTING IS FUN!   !!
ANOTHER LINE? N

READY
#
```

```
 RUN
THIS IS *** COMPUTER CODER ***
YOUR OWN SECRET MESSAGE TOOL.

YOU CAN ENCODE OR DECODE ONE
32 CHARACTER LINE AT A TIME.
WANT TO 'CODE' OR 'DECODE'? CODE
WANT A RANDOM CODE? N
TYPE A FOUR DIGIT NUMBER THAT
IS GREATER THAN 1000
? 9753


WHAT LINE DO YOU WANT CODED? NOW THAT YOU SOLVED MY PUZZLE

PLEASE STAND BY WHILE I WORK

O.K., I'M READY TO GO AHEAD.

YOUR SECRET CODE NUMBER IS 9753

WHAT PORT FOR OUTPUT? 3

PRESS 'RETURN' TO PRINT?


OQZ$UJDX![RY!URPWGG$N[#TV\]PF"#$
ANOTHER LINE? Y
WHAT LINE DO YOU WANT CODED? WITH YOUR PERSONAL COMPUTER

PLEASE STAND BY WHILE I WORK

O.K., I'M READY TO GO AHEAD.

YOUR SECRET CODE NUMBER IS 9753

WHAT PORT FOR OUTPUT? 3

PRESS 'RETURN' TO PRINT?


XKWL![RYS"SISURRBN#GPOSYUGU$!"#$
ANOTHER LINE? Y
WHAT LINE DO YOU WANT CODED? YOU CAN CODE YOUR OWN MESSAGES.

PLEASE STAND BY WHILE I WORK

O.K., I'M READY TO GO AHEAD.

YOUR SECRET CODE NUMBER IS 9753

WHAT PORT FOR OUTPUT? 3

PRESS 'RETURN' TO PRINT?


ZQX$DCQ$DQGI![RYS"R[O"PITUDKFUI$
ANOTHER LINE? N

READY
#
```

Program Listing

```
0010 REM ********************************
0020 REM * SECRET MESSAGE CODER/DECODER *
0030 REM ********************************
0040 REM *         COPYRIGHT 1980       *
0050 REM *              BY              *
0060 REM *     W.B. & W.K. GOLDSMITH    *
0070 REM *    LAKEWOOD, CALIF.  90712   *
0080 REM ********************************
0090 DIM A(32),C(4)
0100 PRINT "THIS IS *** COMPUTER CODER ***"
0110 PRINT "YOUR OWN SECRET MESSAGE TOOL."
0120 PRINT
0130 PRINT "YOU CAN ENCODE OR DECODE ONE"
0140 PRINT "32 CHARACTER LINE AT A TIME."
0150 INPUT "WANT TO 'CODE' OR 'DECODE'",Z$
0160 IF LEFT$(Z$,1)="D" THEN 600
0170  A=INT(10000*RND)
0180 IF A<1000 THEN 170
0190 INPUT "WANT A RANDOM CODE",Z$
0200 IF LEFT$(Z$,1)="Y" THEN 220
0210 GOSUB 9000:REM ** INPUT CODE NUMBER **
0220 PRINT
0230 PRINT
0240 PRINT
0250 INPUT "WHAT LINE DO YOU WANT CODED",A$
0260 PRINT
0270 GOSUB 8000:REM ** PUT MESSAGE LINE INTO A(X) MATRIX **
0280 PRINT "YOUR SECRET CODE NUMBER IS ";A
0290 PRINT
0300 GOSUB 7000:REM ** SELECT OUTPUT DEVICE **
0400 REM ** PRINT THE CODED MESSAGE LINE ***********
0410 PRINT
0420 GOSUB 5000: REM ** PUT THE CODE NUMBER IN C(X) MATRIX **
0430 FOR X=0 TO 7
0440 FOR Y=1 TO 4
0450 PRINT CHR$(A((4*X)+Y)+(Y));
0460 NEXT Y
0470 NEXT X
0480 PRINT
0490 GOSUB 6000: REM ** ANOTHER LINE ? **
0500 GOTO 250: REM ** IF SO GOTO INPUT ROUTINE **
0600 REM ** MESSAGE DECODER *************************
0610 PRINT
0620 PRINT "TYPE IN THE CODE NUMBER FOR"
0630 PRINT "THIS MESSAGE.";
0640 GOSUB 9030: REM ** INPUT CODE NUMBER **
0650 PRINT
0660 INPUT "WHAT LINE DO YOU WANT DECODED",A$
0670 PRINT
0680 GOSUB 8000: REM ** PUT THE MESSAGE INTO A(X) MATRIX **
0700 REM ** PRINT THE DECODED MESSAGE LINE **********
0710 GOSUB 7000: REM ** SELECT THE OUTPUT DEVICE **
0720 GOSUB 5000 : REM ** PUT THE CODE NUMBER IN C(X) MATRIX **
0730 FOR X=0 TO 7
0740 FOR Y=1 TO 4
0750 PRINT CHR$(A((4*X)+Y)-(Y));
0760 NEXT Y
0770 NEXT X
0780 PRINT
0790 GOSUB 6000:REM ** ANOTHER LINE ? **
0800 GOTO 660: REM ** IF SO GOTO INPUT ROUTINE **

5000 REM ** PUT THE CODE NUMBER IN USABLE FORM ******
5010  C$=STR$(A)
5020 FOR X=1 TO 4
5030  C(X)=VAL(MID$(C$,X,1))
5040 NEXT X
5050 RETURN
6000 REM ** ANOTHER LINE OR END SUBROUTINE **********
6010 PORT= 1
6020 INPUT "ANOTHER LINE",Z$
6030 IF LEFT$(Z$,1)="Y" THEN RETURN
6040 END
7000 REM ** OUTPUT DEVICE SELECT SUBROUTINE *********
7010 INPUT "WHAT PORT FOR OUTPUT",P
7020 PRINT
7030 INPUT "PRESS 'RETURN' TO PRINT",Z$
7040 PORT= P
7050 PRINT
7060 RETURN
8000 REM ** MESSAGE LINE INPUT SUBROUTINE ***********
8010 PRINT "PLEASE STAND BY WHILE I WORK"
8020  B$="                                "
8030  A$=A$+B$
8040 PRINT
8050 FOR X=1 TO 32
8060  A(X)=ASC(MID$(A$,X,1))
8070 NEXT X
8080 PRINT "O.K., I'M READY TO GO AHEAD."
8090 PRINT
8100 RETURN
9000 REM ** CODE NUMBER INPUT SUBROUTINE ************
9010 PRINT "TYPE A FOUR DIGIT NUMBER THAT"
9020 PRINT "IS GREATER THAN 1000"
9030 INPUT A
9040  A=INT(A)
9050 IF A>9999 THEN 9000
9060 IF A<1000 THEN 9000
9070 RETURN
```

Whether you let the computer generate the code key number or select it manually, line 280 returns it to you at the control terminal. Line 300 steers the program to the subroutine in 7000 that allows you to pick a different terminal or device for program output. In my implementation, only the coded message will appear on the "different" terminal, which helps the message security. (The code really looks like random musings of a deranged TTY.)

Statements 400 through 500 are the business end of the coder routine. First, the code number is converted from one four-digit number into four one-digits by the subroutine at line 5000. The number is first converted to a string representation, then each digit is stripped out as a string and re-converted to a numeric value and stored in matrix C(x). The operation could just as readily have been handled without the conversions by a sequence of:

```
 A SECRET MESSAGE FOR PERSONAL COMPUTING
READERS EVERYWHERE:

THE SECRET CODE NUMBER IS 9753

OQZ$UJDX!(RY!URPWGG$N(#TV\)PF"#$
XKWL!(RYS"SISURRBN#GPOSYUGU$!"#$
ZQX$DCQ$DQGI!(RYS"RIO"PITUDKFUI$

DECODE THIS MESSAGE WITH YOUR PERSONAL
COMPUTER AND ENJOY A NEW DIMENSION OF
RECREATION WITH YOUR ELECTRONIC PAL.
```

For the answer to the three-line secret message, turn to page 108.

5010 C(1)=INT (A/1000)
5020 C(2)=INT ((A-C(1))/100)
5030 C(3)=INT-((A-C(1)-C(2))/10)
5040 C(4)=A-C(1)-C(2)-C(3)

Each method takes four lines of BASIC code, so take your choice. (Remember not to disturb the contents of variable "A"—you need it intact for later lines.)

The nested FOR/NEXT loops of 430 through 470 do the actual coding. The message letters are modified in ASC II code in the print statement by the second "+(Y)". The first is used to make the nested FOR/NEXT step through the entire 32-character line.

The subroutine at 6000 (which is called by line 490) gives you the option of coding another line with the same code key. If you don't want another line, the subroutine provides the END statement. If another line is desired, RETURN allows the program to go back to the message input line through the GOTO at statement 500.

The reader sequence of lines 600 through 800 echoes the coding path. 600 through 640 allow input of the code key. The GOSUB in 640 enters the code entry subroutine after the prompt to save a few print lines. Line 660 is the message input line. The subroutines at 8000, 7000 and 5000 repeat exactly as before. The nested FOR/NEXT loop of 730 through 770 does the decoding. The actual decoder is the last term in 750 ("-(y)"). The "-Y" cancels the shift added by the "+Y" in line 450. As before, the subroutine at 6000 lets you decode another line with the same code key number. □

CRYPTO

BY ROBERT E. KENNEDY

When my wife and I bought a Northstar Horizon microcomputer, I could hardly wait to use the power of our computer to aid me in another area of personal interest which I have — solving cryptograms. In particular, I am referring to what is sometimes called the "aristocrat of crypts." That is, a cryptogram which is in the form of a simple substitution cipher with word-division and in which the message is of minimal importance. Hence, the crypt-solver's full attention has to be on the frequency and variety of contacts of each letter which makes up a given cryptogram.

Even though many crypt-solvers have been successful by considering letter frequency only, it is usually the case that frequencies are distorted from all similarity to the "normal" frequency distribution of the letters in a given sample of text. Thus, even though the letter "E" occurs more often on the average than any other letter of the alphabet, it is not unusual to come upon a cryptogram in which the letter "E" occurs less frequently than most of the other letters.

Contact

It is, however, difficult for a cryptogram constructor to disguise the "variety of contacts" of letters. Thus, I start an analysis of a cryptogram by constructing a "letter contact chart" for each letter which occurs in the cryptogram. For example, consider the short cryptogram:

ABCD CEA AFGEAFCH.

A contact chart for the letter "A" would be:

$$A\ \frac{-E-E}{B-F\ F}$$

which indicates that "A" has "E" as its only predecessor while it has successors "B" and "F". The "—" represents a non-alphabetic character (usually a blank, period, etc.). The complete list of contact charts for the above cryptogram is:

$$A\ \frac{-E-E}{B-F} \qquad B\ \frac{A}{C}$$

$$C\ \frac{B-F}{D\ E\ H} \qquad D\ \frac{C}{-}$$

$$E\ \frac{C\ G}{A\ A} \qquad F\ \frac{A\ A}{G\ C}$$

$$C\ \frac{F}{E} \qquad H\ \frac{E}{-}$$

Next, I arrange each letter in a table with its frequency indicated to the left, and the number of its distinct contacts to the right. In addition, this table is sorted in order of increasing number of distinct contacts. The result is called a "frequency/contact table." Such a table for the above cryptogram is:

FREQUENCY		CONTACTS
1	D	1
1	H	1
1	B	2
1	G	2
4	A	3
2	E	3
2	F	3
3	C	5

Here we see, for example, that "C" occurs 3 times and that it has 5 distinct contacts.

The 20% Rule

Through the years, expert cryptogram solvers have come to the conclusion that about 20% of the total contact variety count from the top of such a table will probably represent consonants. Since the total of the numbers in the "contact" column is 20, this rule of thumb states that a count of about 4 (20% of 20 is 4) contacts from the top of the table will correspond to consonants. So, according to this, "D", "H" and "B" and/or "G" are probably consonants.

I would like to make a comment or two about the above process. First, it should be emphasized that because of the short length of the above cryptogram, it probably has many solutions. A good and fair cryptogram should have between 75 and 90 letters, at least 18 of which are different. Secondly, some crypt-solvers include "Y" among the vowels while some do not. I personally consider "Y" as a vowel, but with the reservation that it could be one of the "consonants" indicated by the "20% rule."

The Program

The process of making contact charts and a frequency-contact table for a given cryptogram is faster and more efficient by using the CRYPTO program that I run on my microcomputer. It is written in Northstar BASIC, which differs slightly from other BASIC dialects. For example, the Ith member of a string, Z$, is represented by Z$(I,I) instead of Z$(I) or LEFT$(Z$,I) as in other BASICs.

This program does even more than give a copy of all the contact charts, the frequency-contact table (sorted with respect to the number of distinct contacts) and some probable consonants from the low-contact end of the table. It also allows you to input your substitutions, and display the results in a continuously interactive manner. Hence, using this program is like using paper and pencil without the problem of erasing holes through the paper because of continually changing your mind about a particu-

Figure 1

```
$
O O W E I O X W Z O                                  FREQUENCY =  10
A <-----------------------------------------LETTER--
- N Z K - B S I T -                          NO OF CONTACTS =  11

N - A -                                              FREQUENCY =  4
B <-----------------------------------------LETTER--
D I T T                                     NO OF CONTACTS =  4

- N                                                  FREQUENCY =  2
C <-----------------------------------------LETTER--
T T                                         NO OF CONTACTS =  2

B                                                    FREQUENCY =  1
D <-----------------------------------------LETTER--
V                                           NO OF CONTACTS =  2

I W T - O Z U J                                      FREQUENCY =  8
E <-----------------------------------------LETTER--
A I X X K W T X                             NO OF CONTACTS =  10

- - N H                                              FREQUENCY =  4
H <-----------------------------------------LETTER--
N J H J                                     NO OF CONTACTS =  3

- X K E A T                                          FREQUENCY =  6
I <-----------------------------------------LETTER--
N E A X O O                                 NO OF CONTACTS =  7

Z H P W H                                            FREQUENCY =  5
J <-----------------------------------------LETTER--
- - - - E                                   NO OF CONTACTS =  5

A Z O T E                                            FREQUENCY =  5
K <-----------------------------------------LETTER--
I - N S P                                   NO OF CONTACTS =  9

N                                                    FREQUENCY =  1
M <-----------------------------------------LETTER--
N                                           NO OF CONTACTS =  1

A - I H - K M W O                                    FREQUENCY =  9
N <-----------------------------------------LETTER--
Z Q B Z Q M P C H                           NO OF CONTACTS =  12

w w W I I W -                                        FREQUENCY =  7
O <-----------------------------------------LETTER--
A A A K E A N                               NO OF CONTACTS =  6

N K                                                  FREQUENCY =  2
P <-----------------------------------------LETTER--
J -                                         NO OF CONTACTS =  3

N N                                                  FREQUENCY =  2
Q <-----------------------------------------LETTER--
- -                                         NO OF CONTACTS =  1

A K Z                                                FREQUENCY =  3
S <-----------------------------------------LETTER--
- - -                                       NO OF CONTACTS =  3

C B B Z - A C B E                                    FREQUENCY =  9
T <-----------------------------------------LETTER--
X w W E K I Z W -                           NO OF CONTACTS =  9

-                                                    FREQUENCY =  1
U <-----------------------------------------LETTER--
E                                           NO OF CONTACTS =  1

D w                                                  FREQUENCY =  2
V <-----------------------------------------LETTER--
W Z                                         NO OF CONTACTS =  3

- - V T T - - T E - X                                FREQUENCY =  11
W <-----------------------------------------LETTER--
O O A O E A N V J O X                       NO OF CONTACTS =  8
```

(Fig. 1 continued on page 50)

lar substitution. At each stage of the program, the options of correcting an input line, outputting hard copy, continuing, and starting over are also given.

Up to three lines of input are allowed with CRYPTO. The program can, of course, be modified to accept more lines, but for most cryptograms, three lines are more than ample. For an example of how CRYPTO operates, consider the following cryptogram:

WOA WOANZJ NQ
INBDVWAZ XIEAKIA CTX
HNZK NQ
BTWOABTWEIX, ZTEXAS
HJ WAIOKNMNPJ TKS
EX ZATIOEKP WNCTZS
BTWVZEWJ UET
WOA ONHHJEXWX.

After loading and entering "RUN", you will be asked: DO YOU WISH HARDCOPY? (YES/NO)

This gives you the option of having hard copy made of the contact charts and the frequency-contact table for the cryptogram (usually it is a good idea to have such hard copy). After this decision is made, you are directed to enter the cryptogram one line at a time (up to 75 characters per line). You will then have the opportunity to make corrections at this point. If no corrections are needed, then the contact charts, frequency-contact table, etc., are output. For example, if the above cryptogram is entered, the result is that of Figure 1.

On the CRT, Figure 2 will be displayed with the following message:

THE ENTERING OF THE WORD 'CLEAR' WILL CAUSE A RESTART. DO YOU WANT TO MAKE A SUBSTITUTION? (YES/NO/CLEAR)

directly below it.

If "YES" is entered, you will then be asked what letter is to be replaced, by what, and whether you wish hard copy. If "NO" is entered, you are asked if you do indeed wish to terminate the session, and if so, whether or not you wish hard copy of the current result. So, if "YES" is entered in the above, because you would like to replace the letter "A" by the letter "E", then the sequence of

(Fig. 1 continued)

```
- T I E E E W                                        FREQUENCY =  7
X <-------------------------------------LETTER--
I - - A - W -                                    NO OF CONTACTS =  5

N A N - - T V                                       FREQUENCY =  7
Z <-------------------------------------LETTER--
J - K T A S E                                    NO OF CONTACTS =  8
FREQ.          CONTACTS

  1------M------  1

  2------Q------  1

  1------U------  1

  2------C------  2

  1------D------  2

  4------H------  3

  2------P------  3

  3------S------  3

  2------V------  3

  4------B------  4

  5------J------  5

  7------X------  5

  7------O------  6

  6------I------  7

 11------W------  8

  7------Z------  8

  5------K------  9

  9------T------  9

  8------E------ 10

 10------A------ 11

  9------N------ 12

THE TOTAL NUMBER OF DISTINCT CONTACTS IS  113.
THUS, ORDINARILY ABOUT  22 OF THE TOTAL
NUMBER OF CONTACTS FROM THE TOP OF THE ABOVE LIST WILL
BE CONSONENTS.
```

Figure 2

```
---  -------  --  --------  -------  ---  ----  --
WOA  WOANZJ   NQ  INBDVWAZ  XIEAKIA  CTX  HNZK  NQ

----------   ------  --  ----------  ---  --
BTWOABTWEIX, ZTEXAS  HJ  WAIOKNMNPJ  TKS  EX

--------  ------  --------  ---  ---  ---------
ZATIOEKP  WNCTZS  BTWVZEWJ  UET  WOA  ONHHJEXWX.
```

questions and responses would be that of Figure 3A. Figures 3B and 3C are examples of further substitutions, while Figure 3D is an example of how to change your mind on a particular substitution.

Continuing, the actual message will hopefully start to be more and more apparent. Of course, no method is an automatic cryptogram solver. You must use a combination of skill, luck and intuition, which can only be developed from actual attempts and successes (or failures) at the solution of cryptograms. To help you finish the above cryptogram, I would like to conclude by listing some maxims of which every crypt-solver should be aware:

- *All words contain at least one vowel.*
- *Letters of very low frequency are often consonants.*
- *Letters contacting low-frequency letters are often vowels.*
- *If a pair of letters and its reversal appear in a cryptogram, then usually one is a vowel and the other is a consonant.*
- *More than two successive vowels usually do not occur in a word.*
- *More than three successive consonants usually do not occur in a word.*
- *A vowel usually shows a tendency to have a larger number of contacts than its frequency while the reverse is usually true of consonants.*

Conclusion

There are other maxims such as the above, but you will discover and develop some of your own as you work at solving cryptograms. One way to develop a feel for the above maxims is to enter various samples of plain text and study them in light of these maxims. I encourage you to use CRYPTO together with the above maxims as an aid to solving cryptograms. After a few sessions using CRYPTO, you will find (as I have) that you will have improved your cryptogram solving ability with respect to both the length of time you spend and the number of successes you are able to achieve. □

(Program Listing on page 52)

Figure 3

```
THE ENTERING OF THE WORD 'CLEAR' WILL CAUSE A RESTART.

DO YOU WANT TO MAKE A SUBSTITUTION? (YES/NO/CLEAR ) YES

WHAT LETTER DO YOU WANT TO REPLACE? A

BY WHAT LETTER? E

DO YOU WISH HARDCOPY? (YES/NO) YES

--E  --E---  --  -----E-  ---E--E  ---  ----  --
WOA  WOANZJ  NQ  INBDVWAZ  XIEAKIA  CTX  HNZK  NQ

----E------  ----E-  --  -E--------  ---  --
BTWOABTWEIX,  ZTEXAS  HJ  WAIOKNMNPJ  TKS  EX

-E------  ------  --------  ---  --E  ---------
ZATIOEKP  WNCTZS  BTWUZEWJ  UET  WOA  ONHHJEXWX.
```

(A)

```
THE ENTERING OF THE WORD 'CLEAR' WILL CAUSE A RESTART.

DO YOU WANT TO MAKE A SUBSTITUTION? (YES/NO/CLEAR ) YES

WHAT LETTER DO YOU WANT TO REPLACE? N

BY WHAT LETTER? O

DO YOU WISH HARDCOPY? (YES/NO) YES

--E  --EO--  O-  -O----E-  ---E--E  ---  -O--  O-
WOA  WOANZJ  NQ  INBDVWAZ  XIEAKIA  CTX  HNZK  NQ

----E------  ----E-  --  -E---O-O--  ---  --
BTWOABTWEIX,  ZTEXAS  HJ  WAIOKNMNPJ  TKS  EX

-E------  -O----  --------  ---  --E  -O-------
ZATIOEKP  WNCTZS  BTWUZEWJ  UET  WOA  ONHHJEXWX.
```

(B)

```
THE ENTERING OF THE WORD 'CLEAR' WILL CAUSE A RESTART.

DO YOU WANT TO MAKE A SUBSTITUTION? (YES/NO/CLEAR ) YES

WHAT LETTER DO YOU WANT TO REPLACE? Q

BY WHAT LETTER? N

DO YOU WISH HARDCOPY? (YES/NO) YES

--E  --EO--  ON  -O----E-  ---E--E  ---  -O--  ON
WOA  WOANZJ  NQ  INBDVWAZ  XIEAKIA  CTX  HNZK  NQ

----E------  ----E-  --  -E---O-O--  ---  --
BTWOABTWEIX,  ZTEXAS  HJ  WAIOKNMNPJ  TKS  EX

-E------  -O----  --------  ---  --E  -O-------
ZATIOEKP  WNCTZS  BTWUZEWJ  UET  WOA  ONHHJEXWX.
```

(C)

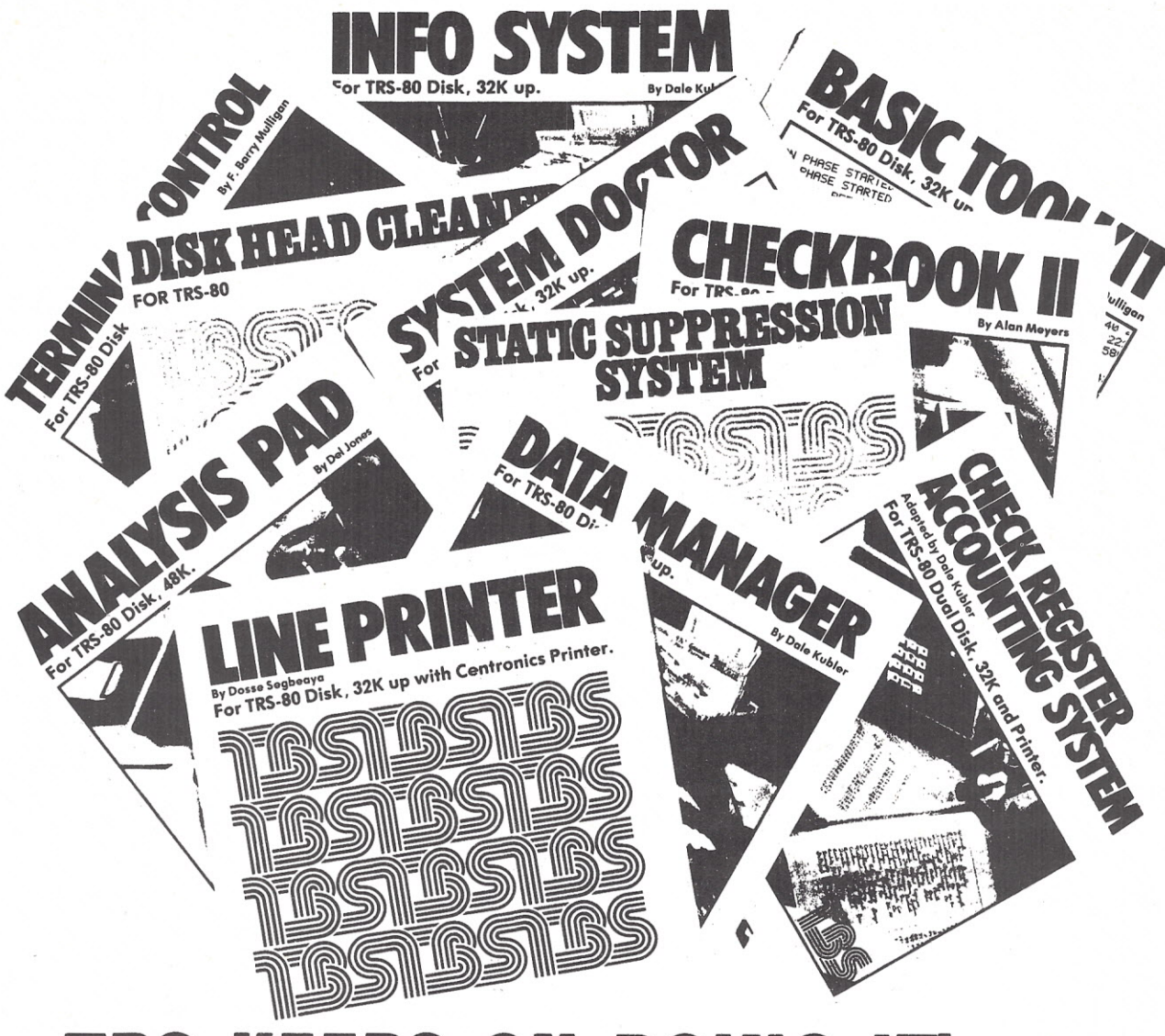
```
THE ENTERING OF THE WORD 'CLEAR' WILL CAUSE A RESTART.

DO YOU WANT TO MAKE A SUBSTITUTION? (YES/NO/CLEAR ) YES

WHAT LETTER DO YOU WANT TO REPLACE? Q

BY WHAT LETTER? F

DO YOU WISH HARDCOPY? (YES/NO) YES

--E  --EO--  OF  -O----E-  ---E--E  ---  -O--  OF
WOA  WOANZJ  NQ  INBDVWAZ  XIEAKIA  CTX  HNZK  NQ

----E------  ----E-  --  -E---O-O--  ---  --
BTWOABTWEIX,  ZTEXAS  HJ  WAIOKNMNPJ  TKS  EX

-E------  -O----  --------  ---  --E  -O-------
ZATIOEKP  WNCTZS  BTWUZEWJ  UET  WOA  ONHHJEXWX.
```

(D)

Program Listing

```
10  REM "CRYPTO"   BY ROBERT E. KENNEDY---JULY, 1980.
20  REM
30  REM  THIS PROGRAM SERVES AS AN AID FOR THE SOLUTION
40  REM  OF CRYPTOGRAMS.
50   DIM S$(230),S1$(75),S2$(75),S3$(75),S1(26),S2(26),C(26),J(26)
60   DIM X1$(75),X2$(75),X3$(75)
70 Q = 0
80 INPUT "DO YOU WISH HARDCOPY? (YES/NO) ",Y$
90 IF Y$ = "YES" THEN Q = 2
100   INPUT "FIRST LINE ? ",S1$
110   INPUT "SECOND LINE ? ", S2$
120   INPUT "THIRD LINE ? ", S3$
130 PRINT \ PRINT
140 INPUT " DO YOU WISH TO RETYPE A LINE? (YES/NO) ", Y$
150 IF Y$ = "YES" THEN 1260
160   S$ = " "+S1$ + " " + S2$ + " " + S3$ + " "
170 FOR I = 1 TO 26
180  C = 0 \ J = 1
190 GOSUB 480
200 IF J = 1 THEN 250
210 GOSUB 530
220 GOSUB 600
230 PRINT #Q \ PRINT #Q
240  J(I) = J-1 \ C(I) = C \ C1 = C1 + C
250  NEXT I
260 GOSUB 340
270 PRINT #Q "FREQ.            CONTACTS" \ PRINT #Q
280 GOSUB 750 \ PRINT #Q
290 PRINT #Q " THE TOTAL NUMBER OF DISTINCT CONTACTS IS ", C1 ,","
300 PRINT #Q " THUS, ORDINARILY ABOUT ",INT(.20*C1) ," OF THE TOTAL "
310 PRINT #Q " NUMBER OF CONTACTS FROM THE TOP OF THE ABOVE LIST WILL"
320 PRINT #Q " BE CONSONENTS."
330 GOSUB 820
340 REM ************ SUBROUTINE WHICH REDEFINES THE TABLE, C(I), SO ***********
341 REM ************ AS TO KEEP TRACK OF ORIGINAL ORDINALITY IN THE ***********
342 REM ************ FREQUENCY-CONTACT TABLE W/R TO APHABETIC ORDER ***********
343 REM ************ WHEN SORTED W/R TO NUMBER OF CONTACTS.         ***********
350 FOR I = 1 TO 26
360 C(I) = 100*C(I) + I
370 NEXT I
380 FOR K = 26 TO 2 STEP -1
390 G = C(K)
400    FOR J = 1 TO K - 1
410    IF G >= C(J)  THEN 450
420    T = G
430    G = C(J)
440    C(J) = T
450    NEXT J
460 C(J) = G
470 NEXT K \ RETURN
480 REM************************** DETERMINES PREDECESSORS AND SUCCESSORS ******
481 REM ************************** OF EACH LETTER WHICH OCCURS.           ******
490  FOR K = 2 TO LEN(S$)-1
500  IF CHR$(I+64) <> S$(K,K) THEN 520
510 S1(J) = ASC(S$(K-1,K-1)) \ S2(J) = ASC(S$(K+1,K+1)) \ J = J + 1
520  NEXT K  \ RETURN
530 REM***************** COUNTS DISTINCT NUMBER OF CONTACTS FOR EACH LETTER ****
540 FOR R = 1 TO 26
550   FOR P = 1 TO J-1
560   IF S1(P) = R + 64  OR S2(P) = R + 64 THEN C = C + 1
570   IF S1(P) = R + 64  OR S2(P) = R + 64 THEN EXIT 590
580   NEXT P
590 NEXT R \ RETURN
600 REM ********** SUBROUTINE FOR LISTING THE CONTACTS FOR EACH LETTER *********
610  FOR M = 1 TO J-2
620 IF S1(M) > 90 OR S1(M) < 65 THEN S1(M) = 45
630  PRINT #Q CHR$(S1(M))," ",
640  NEXT M
650 IF S1(J-1) > 90 OR S1(J-1) < 65 THEN S1(J-1) = 45
660 PRINT #Q CHR$(S1(J-1)),TAB(55),"FREQUENCY = ",J-1
670  PRINT #Q  CHR$(I+64)," <-----------------------------------LETTER--"
680  FOR M = 1 TO J-2
690 IF S2(M)   > 90 OR S2(M)   < 65 THEN S2(M)   = 45
700  PRINT #Q CHR$(S2(M))," ",
710  NEXT M
720 IF  S2(J-1) > 90 OR S2(J-1) < 65 THEN S2(J-1) = 45
730 PRINT #Q CHR$(S2(J-1)),TAB(50),"NO OF CONTACTS = ",C
```

(Continued on page 54)



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The fine quality software of The Bottom Shelf including its defined fields, editing features and blinking cursor off the Model I Radio Shack microcomputer has been established. Now it is time for the new. With the introduction of the Mod II, TBS went to work learning its secrets. This month will mark the introduction of major advances in business and database software for all Radio Shack computers - Mods I to III and even the little pocket computer. As this is being written, most titles are not known, but see your computer dealer or write for a catalog - all titles released are available at that time.

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CIRCLE 17

```
740 RETURN
750 REM ****** SUBROUTINE FOR OUTPUT OF FREQUENCY-CONTACT TABLE *************
760  FOR I = 1 TO 26
770  K = C(I) - 100*INT(C(I)/100)
780  IF J(K) = 0 THEN 810
790 PRINT #Q X3I,  J(K) , "------"  , CHR$(K+64), "------",INT(C(I)/100)
800  PRINT #Q
810  NEXT I \ RETURN
820 REM *********** SUBROUTINE FOR SUBSTITUTION ****************************
830 Q1 = 0
840  FOR I = 1 TO LEN(S1$)
850    X1$(I,I) = "-"
860 IF ASC(S1$(I,I)) > 90 OR ASC(S1$(I,I)) < 65 THEN X1$(I,I) = " "
870  NEXT I
880  FOR I = 1 TO LEN(S2$)
890    X2$(I,I) = "-"
900 IF ASC(S2$(I,I)) > 90 OR ASC(S2$(I,I)) < 65 THEN X2$(I,I) = " "
910  NEXT I
920  FOR I = 1 TO LEN(S3$)
930    X3$(I) = "-"
940 IF ASC(S3$(I,I)) > 90 OR ASC(S3$(I,I)) < 65 THEN X3$(I,I) = " "
950  NEXT I
960 GOSUB 1340
970 PRINT " THE ENTERING OF THE WORD 'CLEAR' WILL CAUSE A RESTART."
980 PRINT
990 INPUT " DO YOU WANT TO MAKE A SUBSTITUTION? (YES/NO/CLEAR ) ",N$
1000 IF N$ = "NO" THEN GOTO 1190
1010 IF N$ = "CLEAR" THEN GOTO 820
1020 INPUT " WHAT LETTER DO YOU WANT TO REPLACE? ",L1$
1030 INPUT " BY WHAT LETTER? ",L2$
1040 PRINT \ PRINT
1050 FOR I = 1 TO LEN(S1$)
1060 IF S1$(I,I) = L1$ THEN X1$(I,I) = L2$
1070 NEXT I
1080 FOR I = 1 TO LEN(S2$)
1090 IF S2$(I,I) = L1$ THEN X2$(I,I) = L2$
1100 NEXT I
1110 FOR I = 1 TO LEN(S3$)
1120 IF S3$(I,I) = L1$ THEN X3$(I,I) = L2$
1130 NEXT I
1140 INPUT "DO YOU WISH HARDCOPY? (YES/NO) ",Y$
1150 IF Y$ = "YES" THEN Q1 = 2 ELSE Q1 = 0
1160 GOSUB 1340
1170 PRINT #Q1
1180 GOTO 970
1190 PRINT " ARE YOU SURE YOU WANT TO TERMINATE THE PROGRAM (YES/NO) ?  "
1200 INPUT Y$
1210 IF Y$ <> "YES" THEN 990
1220 INPUT "DO YOU WISH HARDCOPY? (YES/NO) ",Y$
1230 IF Y$ = "YES" THEN Q1 = 2 ELSE Q1 = 0
1240 GOSUB 1340
1250 END
1260 INPUT "WHICH LINE? ",Z
1270 ON Z GOTO 1280,1300,1320
1280 INPUT "RETYPE LINE: ",S1$
1290 GOTO 1330
1300 INPUT "RETYPE LINE: ",S2$
1310 GOTO 1330
1320 INPUT "RETYPE LINE: ",S3$
1330 GOTO 140
1340 REM ********************** SUBROUTINE FOR OUTPUT **********************
1350 PRINT
1360 PRINT X1$
1370 PRINT S1$
1380 PRINT
1390 PRINT X2$
1400 PRINT S2$
1410 PRINT
1420 PRINT X3$
1430 PRINT S3$
1440 IF Q1 = 0 THEN 1540
1450 PRINT #Q1 X1$
1460 PRINT #Q1 S1$
1470 PRINT #Q1
1480 PRINT #Q1 X2$
1490 PRINT #Q1 S2$
1500 PRINT #Q1
1510 PRINT #Q1 X3$
1520 PRINT #Q1 S3$
1530 PRINT #Q1
1540 RETURN
```

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CIRCLE 15

How to write for Personal Computing

You've written the programs we want to publish. You – the *Personal Computing* readers – are using your computers in businesses, homes, offices and schools. Other readers, just as software-hungry as you, are eager to try out your programs, your applications and your techniques. So why not share what you've done by submitting an article to *PC?*

It's easier than you might think. Remember: we're more interested in practical programs and useful applications than in fancy prose. And our editorial staff stands ready to help with any problems you encounter in writing your article? Just give us a call at (201) 843-0550.

Here are some handy guidelines to help you get started.

First, decide what kind of article you want to write. Do you have a *business program* that will help an executive, salesman, doctor, lawyer or shopkeeper function more efficiently? Think about how businesses can benefit from microcomputers – not only in the obvious areas of inventory, accounting and payroll, but in all departments and levels right up to the president's desk. Financial and marketing analysis, time management, planning, material handling, product design and cost-accounting are areas ripe for creative programming.

How do you use your computer for *home and personal applications* in your living room, kitchen, study or den? Again, think beyond the obvious areas of checkbook balancing and budgeting (though these areas are far from exhausted) to other applications. Hobbies, home management, household inventory, gardening and landscaping, personal income and expense analysis, personal mailing lists and word processing are just a few ideas to spark your imagination.

What *education programs* have you written for children, adults, professionals, businessmen and teachers? Computers can not only teach children basic subjects such as spelling, math, geography, economics, civics, grammar, literature and science, but can help adults review or sharpen skills in these areas as well. How else can computers function in or out of the classroom to aid learning? To help teachers and administrators?

Are you proficient in some programming technique or special computer area you could explain in a *tutorial article*? How do you save time, money, computer memory or frustration when programming or using your computer? Others can benefit from the same techniques you use.

Your second step is to write the text of the article. Remember, readers aren't familiar with your program. So explain in detail what the program does and how it does it. Include here the overall structure of your program as well as any special algorithms or routines you've used. Give suggestions for modifying or expanding the program for other applications, other businesses or other situations.

Third, prepare your supporting documentation. Include at least a program listing and one or two sample runs, and add program notes to explain any special commands used or other special features of your program. Use charts, diagrams, figures and photos if they help explain your program and its use.

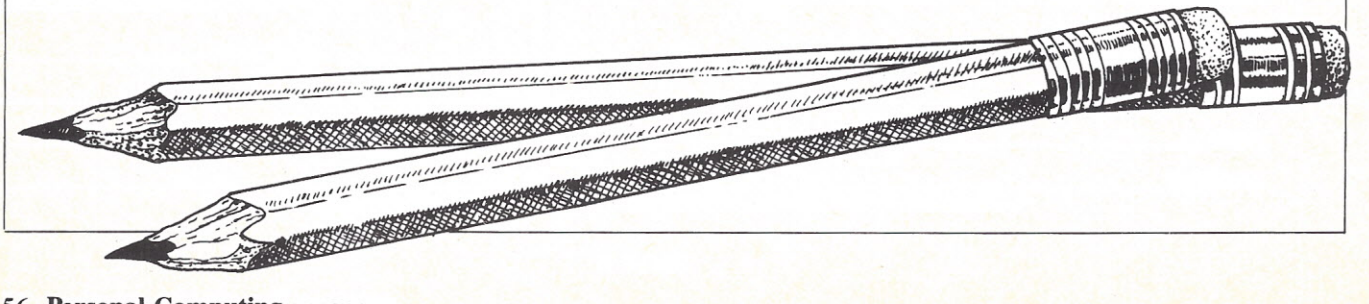
Finally, mail your manuscript. Address it to: Jules Gilder, Editor, Personal Computing Magazine, Hayden Publishing Co., 50 Essex St., Rochelle Park, NJ 07662.

A few suggestions: All submissions should be original, typed (*not* all CAPS), double-spaced and neat. Please include your name and address on the first page of the article and enclose a self-addressed, stamped envelope for return of material.

Since we photograph program listings and sample runs exactly as you send them to us for publication in the magazine, please be sure you use a fresh ribbon for computer printouts. If you don't have a printer, you can type your listings single spaced; but again, be sure you use a new ribbon. (If your program relies heavily on graphics, you can photograph sample runs from your CRT. But take care to avoid distortion due to the curve of the screen.)

Feel free to call us if you have any questions or want to discuss specific ideas. We can give you feedback and suggest appropriate slants and approaches.

We're always looking for fresh, original ideas. While these guidelines will help you in preparing material for *Personal Computing*, don't assume we don't want your idea just because it's not mentioned here. Let us and our readers know what *you're* doing with your computer.



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CIRCLE 18

Everything You Wanted To Know About Printers

BY STANLEY S. VEIT

One of the most useful peripherals that you can add to your computer is a printer. With a printer, you can produce a variety of material ranging from useful program listings to vital hard copy records. A printer can also be the most difficult peripheral to select.

In order for you to make a wise decision when buying a printer, you must know about the different types of machines available and then use that knowledge to evaluate the advantages and disadvantages each type offers.

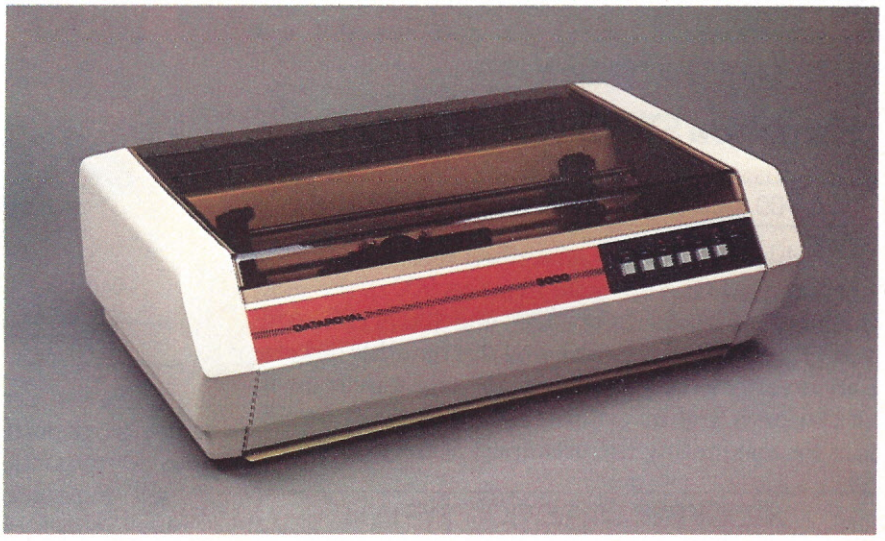
In this article I will discuss: four printer classifications; the types of paper advances found on the machines; controls and indicators for the various units; options you may find available; price ranges; and items you should consider in the way of service.

One of the biggest problems in selecting a printer is due to the large variety of machines on the market. Printers come in all shapes and sizes—from small, quiet, thermal units to large, noisy, impact machines—and a prospective buyer finds a staggering amount of information to wade through. Compounding the problem of masses of information to assimilate, a would-be purchaser also finds a confusing array of classification schemes and strange terminology.

Printers can be classified in a number of ways. Four of the more common categories depend on whether you consider: the input/output (I/O) capabilities of a machine; the method of data transmission to the machine; the print mechanism used; and the manner in which the characters are printed by a unit.

Printer and Printer/Terminals

A printer is a machine with a print mechanism, printing electronics, paper transport mechanism, control electronics and input/output electronics. In addition to having the features of a typical printer, a printer/terminal also has a keyboard with the I/O electronics necessary to transmit or receive data either by direct connection to a computer or through a telephone connection. A printer/terminal is often called a KSR (Keyboard Send/Receive) printer.



The Dataroyal IPS-50000-A, a Receive only dot matrix printer featuring tractor drive, is capable of printing 125 characters per second.

Most KSR units have related models with keyboard and output electronics omitted. Printers that do not have independent output capabilities are referred to as RO (Receive Only) units.

Data Transmission Methods

In a printer (except CRT-xerographic types), all mechanisms operate by the "byte parallel, character serial" method. In other words, the machines operate upon all the bits necessary to define a single character at one time. Data transmission from a computer to a printer, however, may be either by serial or parallel methods thereby providing a classification scheme based on transmission method.

Serial Transmission

In serial data transmission, information is transmitted as a single stream of data bits, with each bit flowing one after the other. Although this form of data transmission is slow compared to the parallel method, it has several advantages. First, serial transmission requires only a single communications channel instead of multiple data lines. Second, serial bits can be transmitted further than parallel bits without special amplification; they can also be transmitted over telephone lines. Third, there are industry standards for equipment interfaces and connectors (such as the RS 232-C and the RS 422) which means computers, printers and cables can be made to interconnect without having to know in advance which brand of printers will be tied together.

Two methods of serial data transmission are used: synchronous and asynchronous.

In synchronous transmission,

words (or characters) are synchronized (with the computer system) at both ends of the transmission cable, because the system must know the exact time position of each byte of data. If no data are transmitted for some time, that time must be filled with "do-nothing" data bits called "nulls." Because of these requirements, elaborate signaling systems (protocols) must be used. Synchronous transmission is therefore used only for transmission at high data rates and is just now starting to appear in small computer systems.

Asynchronous data transmission does not require synchronized timing. Instead, it adds start and stop bits to each transmitted character to signify the beginning and end of the character. Although the method doesn't require special spacing between words, there has to be exact agreement between transmitter and receiver on the speed of data flow. (This speed, called the baud rate, is measured in bits-per-second.) Popular baud rates are 110, 300, 600, 1200, 4800, 9600 and 19,200. Asynchronous transmission is used at rates of up to 1,200 baud. Differences in data transmission rates affect the printing capabilities of a printer. At the slower rates (110 and 300 baud), a printer may be slowed by the data speed; while at higher speeds, a printer must buffer received data to prevent loss of information.

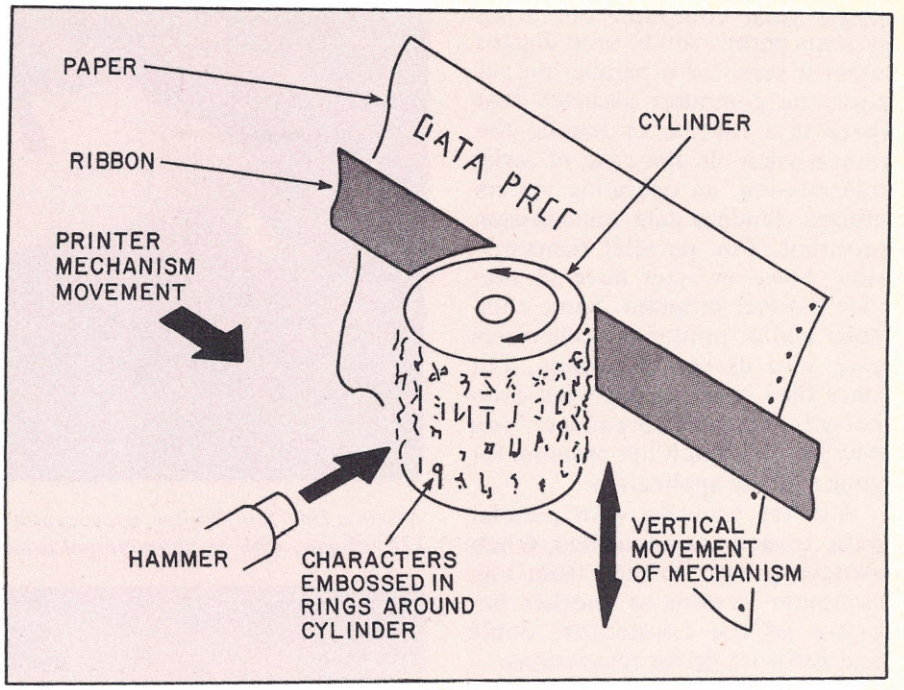


Figure 1 — Cylindrical typing elements, the first low-cost printers for the hobbyist market, could type up to 10 characters per second.

Parallel Transmission Printers

In the parallel method, data are transmitted along parallel wires—usually one wire for each bit necessary to define a character. In addition, there are sometimes extra wires used for control purposes. This method is called "byte parallel, character serial" because data bits for a character are transmitted at one time but the stream of characters comes in serial fashion. (The method is also called "character parallel, word serial" because each character is transmitted in parallel form, while the complete word is received character-by-character.)

Parallel transmission is faster than serial transmission and requires less complicated input/output electronics, but it does have some drawbacks.

First, data should not be transmitted on parallel cables over ten feet long unless special circuitry is used at both ends. At greater distances, signal strengh may fall off or false data may be picked up from the environment. Multi-wire cables can be shielded but they are physically heavy and expensive.

Second, there's no standard for the wiring or the connectors used in parallel data transmission. The nearest thing to a standard is the system used by Centronics Printer Co., whose connectors and wiring scheme have almost become defacto standards. Many computer manufacturers provide a Centronics-type parallel printer connection with their units, but others, who may sell their own brand of printers, use connectors and cables unique to their systems to prevent use of a printer from another manufacturer.

Third, parallel data transmission requires a software driver pro-

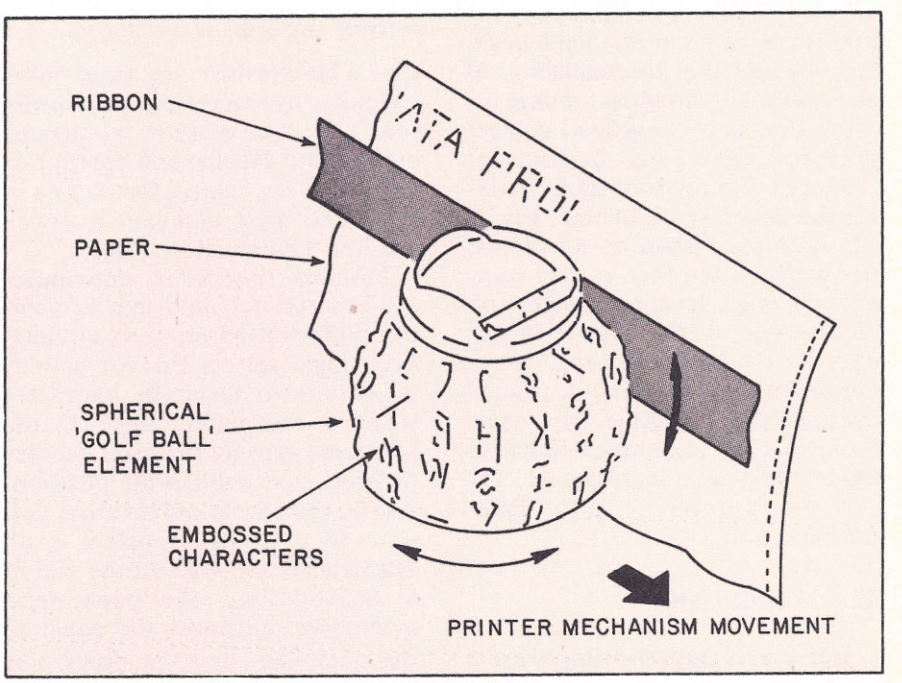


Figure 2 — Spherical typing elements offer a choice of typefaces and operate at printing speeds of up to 15 characters per second. These mechanisms can be seen on any Selectric typewriter.

gram. Most computer operating systems permit you to send data to either a serial or a parallel output port; the computer assumes that there is a routine to handle the transmission. In the case of serial transmission, an operating system utilizes standard data transmission protocol. For parallel transmission, however, you have to provide a driver program. Some computer and/or printer manufacturers give you driver programs, but since they have no idea what components you plan to connect, you may have to patch the program for your specific application.

Another problem with parallel data transmission arises when switching your printer from one computer system to another because of the connector, cable and software driver restrictions.

With all these "problems," you may wonder why so many printers are connected to computers in parallel. The answer is that printing used to be faster with parallel transmission because of slow serial data transmission speeds. It's also cheaper to provide parallel outputs and a lot of printers still adhere to the Centronics standard.

Impact vs. Non-Impact

Although classifiying printers into Printer/Printer Terminal or Serial/Parallel Data Transmission categories is perfectly legitimate, the most common classification relates to a unit's print mechanism and whether that mechanism is of an impact or non-impact nature.

As the name implies, impact printers have a type element that produces a printed image by striking the paper in a machine, generally hitting a ribbon on its way to the paper. There are a wide variety of impact printers available including dot matrix, type element, daisy wheel and others. Non-impact printers produce a printed image without striking the paper. Examples of non-impact units include thermal, electrostatic, ink jet, xerographic and laser machines.

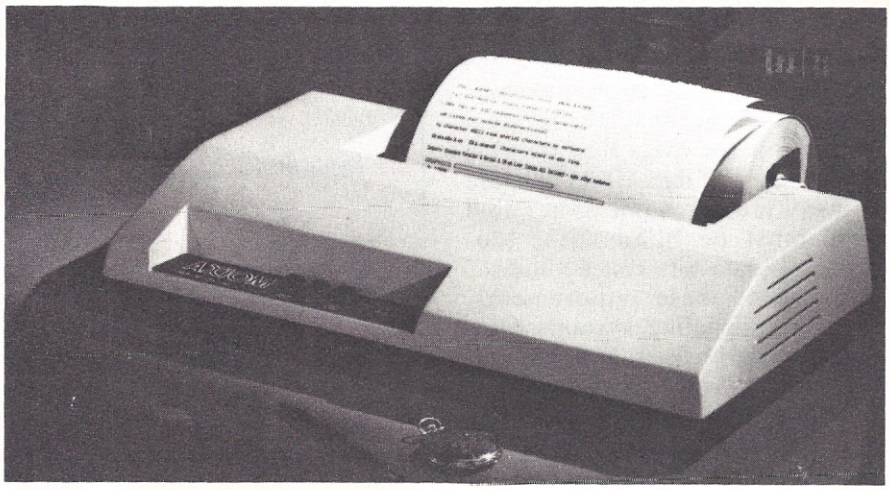
Dot Matrix Units

Dot matrix impact printers use a movable print head that consists of a matrix of small tubes, each of which contains a fine wire or needle. The needles are fired individually by electrical solenoids (devices that convert electrical energy into mechanical energy) to produce a dot matrix that varies in size. The most common matrices are 7 × 9 dots or 9 × 9 dots.

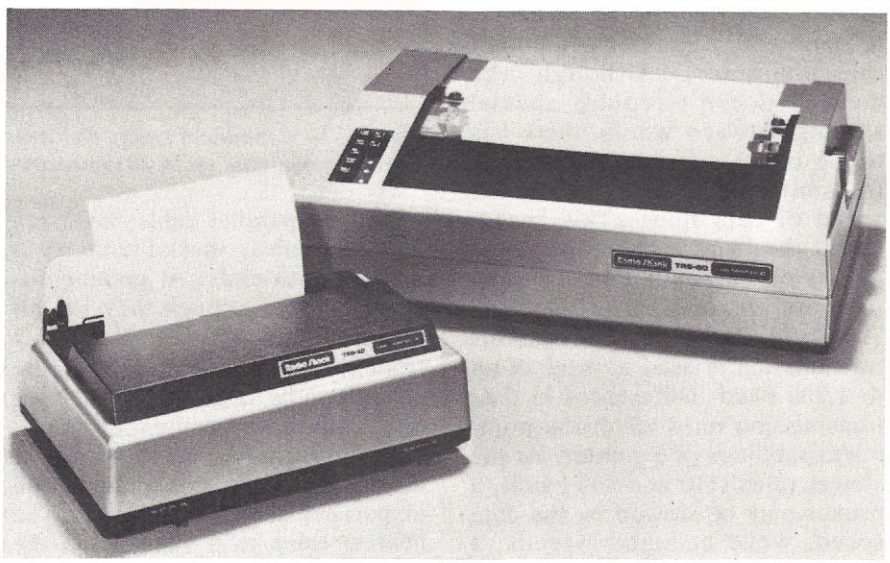
For a matrix printer, a computer sends character data into a memory buffer in the printer's circuits. Print logic selects the dot pattern necessary to form the character that's in the buffer, and fires the solenoids causing the print needles to impact at each print position. As the print head moves from column to column, it prints each character in the line. At the end of a printed line, the paper-feed mechanism advances the paper to the next line, and the process is repeated.

In most matrix machines, an inked ribbon makes the impression on the paper although a special paper containing micro-bubbles of ink can produce the same results. (The bubbles of ink break upon impact and release the ink, leaving an image on the surface of the paper.)

The dotted appearance typically associated with computer printouts is produced by matrix printers—the higher the density of the matrix, the better the printing. Several manufacturers now produce dot matrix printers that almost equal the print quality of solid type. This high quality printing is achieved by having a print head make several passes over a print line with the head position offset slightly on each pass. Multiple passes fill in the spaces between the dots and produce solid-looking type. Printing speed is reduced by such multiple passes, but



Axiom's IMP MiniPrinter, a low-profile dot matrix unit capable of printing 80, 96 or 132 columns with its bidirectional print head, has full graphics capabilities.



Radio Shack's Line Printer II (left) is a 7 × 7 dot matrix unit that prints 80 columns at 50 characters per second. The Line Printer III offers a 9 × 7 matrix, 132-column printing and a speed of 120 CPS.

the resulting type is of a higher quality than that from a single-pass machine.

Solid Type Printers

Solid type impact printers use type fonts mounted on elements such as a balls, thimbles or daisy wheels, or have type fonts that are mounted on drums, chains, bands or wheels. Since the type on these machines is solid, and since the printers can usually be adjusted to give sharp impressions, a solid type unit generally produces better looking print than that from a matrix unit.

Type Element Printers

Type element printers are largely electro-mechanical. A typical unit receives a character code from the computer, translates the electrical code into positional information for the type element, and then causes the correct character to be hit against ribbon and paper. The type element then moves to the next position and repeats the process.

The original type element printer was the Teletype™ which had its type mounted on a cylinder (see Figure 1). Later, the IBM Selectric™- type ball mechanism (see Figure 2) was built into a computer terminal to become the first real, high-quality terminal/printer. The Selectric mechanism's chief drawback is its slow printing speed of 10 to 15 characters per second—about the speed of a fast typist, which, while good enough for character input, isn't really fast enough for computer printouts.

Teletype Models 33, 35 and 38 work well when properly interfaced, but are noisy, slow and increasingly hard to maintain. Selectric mechanism units are also slow and many of them have been used beyond their natural life cycles. In addition, units sold by IBM as terminals for IBM computers were not ASCII (American Standard Code for Information Interchange) coded, so some method of translation must be used in order for some of these machines to be used with micro or minicomputers that recognize the ASCII code. Many Teletype and Selectric machines are now offered as used equipment at attractively low prices.

Daisy Wheels

The Diablo™ print mechnism, developed by a company that is now part of Xerox Corporation, uses a print element in the form of a petal wheel (see Figure 3) with the end of each petal (therefore, the name daisy) containing a single character. The print wheel is revolved to bring the character detected in the print logic circuits into print position. When the character is in place, a single solenoid fires to print the character. The print head is then advanced to the next print position. Because of the time required to turn the print wheel, a daisy wheel printer is usually slower than a dot matrix machine. It does, however, produce high quality print. Another advantage to this type of unit is that type faces can be changed easily, making such a machine readily adaptable to word processing and similar applications.

Most daisy wheel printers are KSR terminals, but RO models are made for print-only applications. Several companies have converted the Olivetti daisy wheel typewriter to computer use. Some of the conversions feature both input and output capabilities; others are computer output machines only that may still be used as office typewriters.

Although each daisy wheel printer manufacturer offers different features, the significant differences between units are found in terms of speed, cost and service.

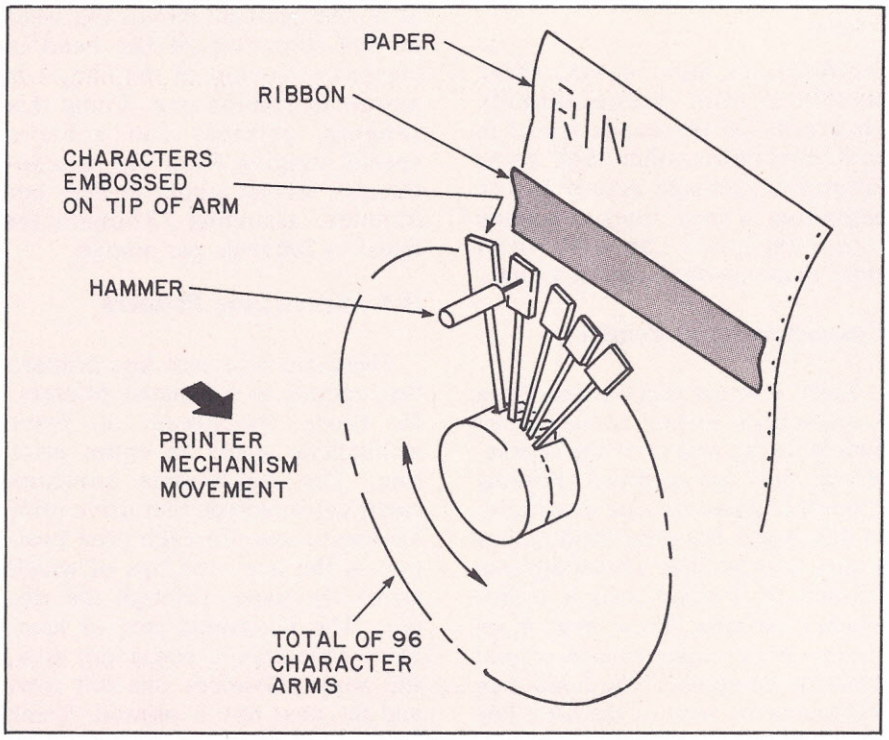


Figure 3 — Daisy wheel printers offer letter quality printing at speeds of up to 55 characters-per-second. A character is contained on the end of each petal.

Non-Impact Printers

As stated earlier, non-impact printers produce characters on special paper without the use of type elements or impact mechanisms. These machines operate at high speeds without the clatter associated with impact printers, but they only produce one copy at a time and they use special papers that are more expensive than those used on other printers.

Thermo-Electric Machines

A thermal printer head consists of a matrix in which any segment of the matrix can be electrically energized to produce heat. This heat acts upon specially treated paper, of which there are several types, to produce characters.

One type of thermal printer, such as Texas Instruments's Silent 700 series, uses a paper coated with a waxy substance. When the matrix moves across the surface of the paper, selected needles heat up to produce black dots that form characters.

Another type of machine uses paper containing micro-spheres of ink that break when heated to produce dotted characters.

A third type of unit uses paper with a thin, metallic coating over a black base. When the print head passes over the paper, the printer generates a small spark between the paper and the proper dots on the print head; the metal coating burns off allowing the black base to show through, thus forming the characters desired.

Ink Jet Spray

One of the fastest types of printers available today operates by spraying a jet of ink through a mask (see Figure 4) onto paper as the head moves along the print line. Masks are selected by printer logic much the same way as type fonts are selectet by an impact printer. This process happens so rapidly that print seems to appear instantaneously. The biggest drawback to ink jet printers shows up when the print mechanism malfunctions, as the head may not only fail to print, but may make a substantial mess as well. Manufacturers claim that new units have fail-safe mechanisms to prevent such malfunctions.

Laser Printers

Laser printers, the fastest machines in the printer industry, have found few applications in personal and small business computer systems. Laser units employ the light from a low-powered laser either to burn a coating off special paper or to produce an image on sensitized photographic paper. The speed of laser printers is limited only by the speed restrictions of the machines' paper-moving mechanisms.

Xerographic Units

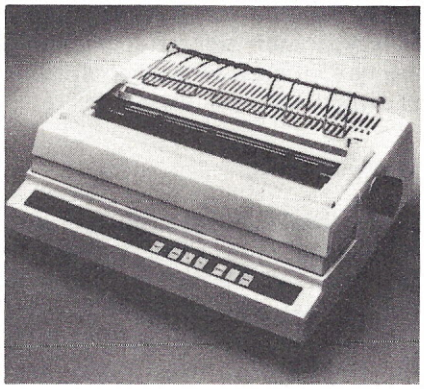
A xerographic printer is a cross between a video terminal and a copying machine. These printers act like high-speed copiers in that the image of a full page is projected by a CRT onto the drum of a xerographic copying machine. In the near future, many copier-type printers will be used in automated office networks.

Line Printers vs. Serial Printers

The last major classification of printers that I'll cover in this article is based on a machine's method of receiving data and printing copy.

Before getting to specifics, however, there is some terminology to explain.

The term "line printer" has two definitions that can be confusing even to people who know a lot about computers. Originally, a line printer was a machine that accepted large blocks of data and then printed a full line at one time. Today, however, printers that accept at least one full line of data and then print the line serially (but very rapidly) are also called line printers because the units cannot print until they have at least one full line of data in their memories



Diablo's Model R0630 daisy wheel printer features changeable print wheels.

(buffers). In most cases, these machines print bidirectionally (they print as the heads travel in both directions rather than going through a carriage return before beginning a new line). In some cases, the units can even print more than one character at a time.

Character-Serial Printers

Serial printers receive data from a computer either in serial or parallel form, and print the characters as they are received. Printing is unidirectional (in one direction). In this mode, the print head moves across a print line advancing one column at a time until it either reaches the end of the line or receives a carriage return signal from the computer. The head then returns to the start of the print line to begin the next line. Most of the slower printers on the market are character serial printers with speeds ranging from 15 characters per second to 100 characters per second.

Line-Buffered Serial Printers

So-called "line printers" that operate serially, take in a full line of characters from the computer. These machines should really be called "line buffered serial printers." When a line buffer is full, printer logic inhibits the receipt of additional data and determines the position of the print head. If the head is at the end of a print line, the mechanism starts printing as it moves toward the beginning of the next line—the last character of a line will be printed first in its correct position in the line. Once a line is printed, printer logic permits the buffer to refill; paper logic advances the paper by one line (line feed); and the print cycle starts over from the first print position. A line buffer can refill at either end of a print line and printing occurs in both directions.

If a carriage return signal is received before the end of a full line, printing stops, the paper advances one line, and printer logic determines in which direction to move the print head to provide the fastest print time for the next line. If the print mechanism is closer to the end of a line than the beginning of it, the machine moves the head in that direction; if the head is closer to the start of the line, it is moved to column one. Using this scheme, printers can achieve speeds ranging from 180 characters per second (about 81 lines per minutes, assuming 132-character lines) to 200 lines per minute.

Dot Matrix Line Printers

There are now true line printers that operate as dot matrix printers. In these machines, a print mechanism spans an entire print line. The mechanism contains electrical solenoids that drive print hammers—one for each print position in the line—the tips of which strike the paper through the ribbon. The horizontal row of hammers generates a single dot row, the paper advances one dot row, and the next row is printed. Using this method, all the characters in a line are finished together. Since a

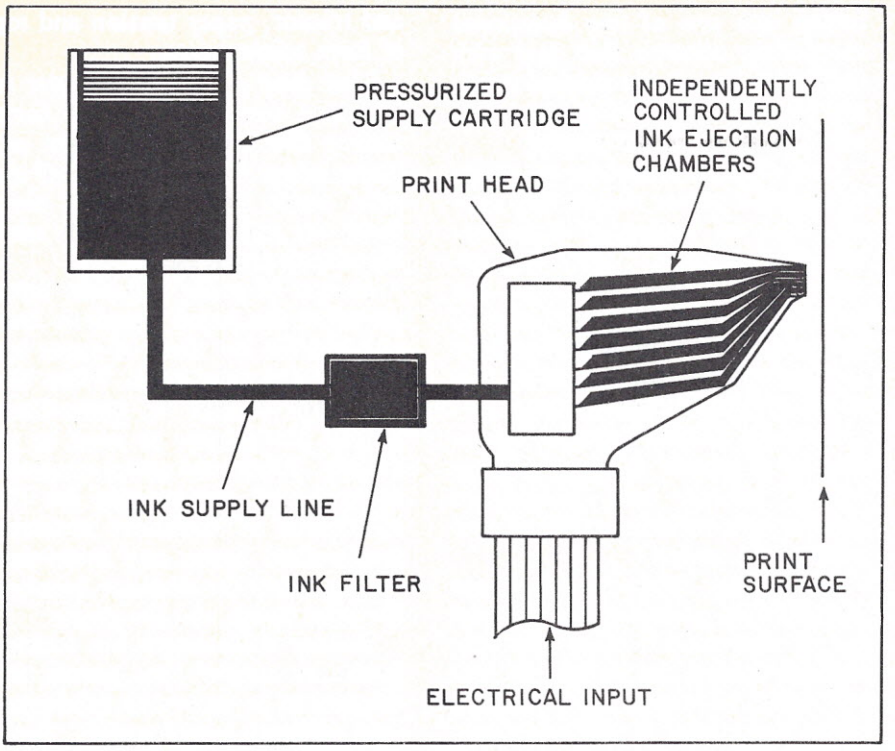


Figure 4 — Ink jet printers use ink jets and masks to produce characters on paper.

character is formed one dot increment at a time, it is possible to print lower case letters with true descenders. It is also possible to print characters in any type face. Printronix, Tally and Okidata make line printers which utilize this method of printing.

Other types of printers

True line printers are usually used with large computers. Line printers have solid type that is mounted on drums, chains or bands. A "train printer" has its type held in a track. Solenoids strike the print elements and cause them to transfer an image to the paper. Some machines use a print hammer and solenoid for each print position, and some share hammers and solenoids among several adjacent positions. In a chain or band line printer, type fonts are mounted on a chain that rotates horizontally across a print line. The fonts contain groups of letters arranged according to frequency of use. Chains or bands often have more than one font installed on them.

A print line on a chain or band printer is usually 80 or 132 columns wide, and there is a row of type for every printable character in the ASCII code. Incoming data are loaded into a buffer until the buffer is full or until a carriage return is detected. At this point, incoming data are inhibited and printer logic "looks" at the line to be printed to determine character position.

As the print chain revolves, the logic causes the solenoid firing circuit to impact the paper and ribbon when the chain moves past a print position. First, all the "A"s in the line are printed at one time, and then, as the chain continues to revolve, the "B"s are printed. The process continues until the chain makes a complete revolution and the entire line is printed. When the line has been printed, an inhibit signal (flag) is lowered, the line buffer refills, and the paper advances to the next line.

Drum printers work much the same as chain or band printers except that the type is mounted on a revolving drum that spans the width of the line. Few drum printers are made today.

Most large line printers are chain or band units that print at speeds from 400 lines per minute, to 1200 lines per minute making them the fastest of all impact units.

Paper Transport Mechanisms

The method a printer uses for moving its paper is one of the most important factors to consider when selecting a machine because it affects both the utility and the cost of the unit. In some cases, paper transport may be the overriding consideration in your choice of equipment.

The three major types of paper transport mechanisms are friction feed, pin feed and tractor feed. Some printers offer a choice of methods as an option; others may be converted from one method to another through simple operator action or factory conversion.

Friction Feed

In a friction feed system, paper is held between, and advanced by, gear-driven rollers like those in a typewriter. Friction feed is the simplest paper transport system and, as anyone who has used a typewriter knows, works very well with single sheets of paper. Problems occur in a friction-feed system, however, when several sheets of paper are used with carbon paper in between because it is hard to keep the sheets in alignment. When long, fan-folded, multi-part forms are used in a friction-feed printer, it becomes impossible to keep everything aligned in the machine; each page will move slightly as the rollers advance the paper, causing misalignment (skew) after a few sheets have passed through the printer.

Pin Feed

Pin feed systems were invented to solve the paper alignment problems characteristic of friction feed machines. Metal pins, mounted around the outer circumference of a roller, fit through holes in the outer margins (sprocket margins) of the paper. Using this system, long rolls and fan-folded boxes of paper and even multi-part forms can be run through a printer without misalignment. The only problem with a pin-feed system is that only one width of paper can be used since the pins are located at the ends of the rollers.

Tractor Feed

Tractor feed, the next improvement in paper-feed mechanisms, involves adjustable sprockets that can accommodate any reasonable paper width up to the size of the paper-feed opening. The sprockets

slide along rods and they can be clamped in place at the desired width.

Since this design eliminates the feed rollers, however, a new method of moving the paper has to be used, and so the movable sprockets are mounted on two chain drives. The drives slide on two, square (or hexagonal) rods that span the width of the paper opening. The rods, which turn by means of a gear train from a drive motor, rotate the sprockets, thereby pulling the paper through the printer—consequently the name "paper tractors."

This entire paper drive can be assembled into a subassembly which can then be installed on a printer. Many printers are sold as friction-feed, or friction-feed/pin feed, machines with a tractor option that can be installed when you need it. Daisy wheel printers and word processing printers use this system. Fast printers designed for use with sprocketed forms eliminate all but the tractor feed mechanism and it cannot be removed.

Paper Feed Selection Criterial

To decide which paper-feed system you need, analyze the type of printing you plan to do now and the kind you expect to be doing in the immediate future.

If your machine is to be used mainly for word processing applications or for single-sized forms, you may find, for instance, that it wouldn't pay to add a tractor feed which will often add hundreds of dollars to the cost of the printer.

If tractor feed is standard on a particular printer, the manufacturer may offer the same model without the tractor for a lower price. On the other hand, another company may offer a low-cost printer with the specifications you want, but the unit may not be adaptable to tractor feed later if you decide you need that capability. Detailed analysis now may mean dollars saved later.

Printer Controls and Indicators

Most printers have few operational controls, so having the more important functions can be important. For purposes of discussion, I will consider a printer control as falling into one of two functional categories: controls that deal with the operation of the printer itself, and controls that deal in some way with the paper in the printer.

One control common to every printer is a power switch that usually has an indicator light associated with it. The best arrangement for these items has the power switch itself at the rear of the printer with the indicator light somewhere in the front of the machine where it can be seen.

Controls dealing with the operation of a printer include: printer select switch and indicator; local/remote switch; and baud rate adjustment switch.

The printer select switch either connects the printer to the computer or removes it from the line without turning the printer off. Often, the indicator light flashes when the printer is receiving data from the line.

Local/remote switches are usually found on printer/terminals. When the switch is in "remote" position, the printer is on-line and is under the control of the computer; when it is in "local" position, the printer and keyboard are not connected to the computer and the terminal keyboard can be used like a typewriter.

On serial input printers, there is usually a switch setting to select the baud rate at which the printer will receive data.

Controls involving a printer's paper can include: line feed, top of form, paper slew, out of paper indicator, print head space control and tractor, paper tension and top of form adjustments.

Line feed causes the printer to advance one line; top of form makes the feed mechanism advance paper to the first line of the next page; and the paper slew feeds the paper continuously until the switch is released.

An out of paper indicator lights up when the paper supply is low, or when the last sheet of paper has entered the print area. When this indicator lights, it sometimes causes the printer to stop or go off-line. Print head space controls, designed to compensate for the difference in thickness between single-sheet paper and multi-part forms, adjust the distance between the print heads and the paper.

Tractor adjustments are locking levers or screws that permit the tractors to be moved to accommodate different paper widths. Some machines may also have smaller adjustments to move the paper slightly in order to align forms. Paper tension adjustments are used in conjunction with the tractor adjustments to keep paper moving smoothly.

Top of form adjustments aid in setting a printer to the top of a form when the paper is being loaded into the unit. This is done so that a top of form signal from the computer will advance the paper to the proper position on the next page. Printers designed for roll paper seldom use this control. On a Teletype machine, for instance, the only top of form control is achieved by counting line

The Model 165 from Malibu, a dot matrix machine with high resolution graphics capabilities, prints 132 columns at speeds ranging from 165 to 198 CPS.

feeds with the software.

Printer Options

Some of the most desirable printer features come as options. One company's options, however, are another firm's features, so it is important to read the specifications of machines you consider buying. It is also important to determine if options can be added to your unit in case you later decide you want to have them.

Options that permit changes in print size are available only on dot matrix printers. In some cases, type size can be changed under software control during printing; in other cases, only one size change is available under the control of a switch on the printer.

As mentioned previously, fonts on type-element printers can be changed merely by switching type elements. The typeface of a dot matrix printer, however, is determined by a character generator chip in the printer's logic circuits.Chip substitution is often a factory modification that you must specify at the time of purchase. In some cases, modifications can be made in the field by qualified service personnel.

Some dot matrix printers offer multiple type fonts that permit type style changes under software control. In these units, the character generator chips contain more than one character set.

Vertical forms control permits you to preset the vertical spacing of the printer. If you're printing information on a form with spaced lines, your program can send a control character to make the printer skip to the next line that requires printing. If your machine doesn't have a vertical forms control, your program has to send single line feed characters until the paper advances to desired line.

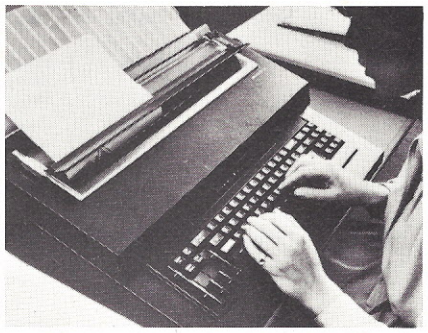
Dot matrix printers increasingly offer an option that permits bypassing the character generator in order to print graphic patterns on paper. This option allows you to transfer CRT graphics to hard copy form.

Some printers interpret a line feed (LF) signal at the end of a print line as including a carriage return (CR); other units require both LF and CR characters to be received. A LF/CR option permits the selection of either automatic line feed and carriage return at the end of a print line, or a carriage return without a line feed. This feature allows to you to first print a line with blanks in it and then go back to fill in the blanks .

Printer Prices

Printers used with personal computer or with small business systems fall into six price classes.

First, there are the low-cost printers designed to be used with personal computers such as the TRS-80, Apple, Pet, TI-99/4, Atari and Ohio Scientific series. Most of these units printers are non-impact units that print up to 80 columns on some type of special paper. The low-end priced units include the PR-40 offered by Southwest Technical Products (kit form for $250) and the Radio Shack Quick Printer. A number of dot matrix printers from the Far East offer good



Electronic typewriters have been converted for use as printers by Howard Industries and Xymec.

quality with a surprising number of desirable features in this low price range. The Base 2, DIP and Microtek printers are especially impressive considering their low prices.

For $600 to $1000, you can find several excellent American-made printers and some high-quality imports. Most of the printers in this price range are 80-column models, although a few offer additional columns with reduced-size print. The Centronics 730 and 737, Okidata Slimline 80 and Integral Data Paper Tiger are typical of the machines at the higher end of this price bracket. They are quality products from established printer manufacturers.

Many of the work horses of the small business computer printer industry are in the $1000 to $2000 bracket. The 700 series from Centronics, Texas Instruments's 810 and 820, Okidata Slimline, DEC Decwriters LA-34 and LA-36, Teletype 43 and other fine printers with both 80- and 132-column capabilities are in this range.

Most of the daisy wheel printers fall in the $2000 to $3000 bracket as do dot matrix serial printers with the most desirable features. A few line printers can be found at the high end of this range but such printers usually cost more.

Daisy wheel printers with the widest carriages and the most features cost $3000 to $5000 as do dot matrix printers with graphics features and multiple fonts. Some of the smaller models of the better commercial data processing printers are also in this price range.

Heavy-duty, serial, dot matrix printers, line printers using band and chain technology, and fast mainframe computer printers are priced from $5000 to $50,000.

Printer Service

Availability, cost and quality of service for a particular printer should be a prime consideration during the selection process. Printer failures always seem to occur when a machine is needed most and service is hard to get.

Many manufacturers maintain service departments in major cities throughout the country. If you buy a printer from a dealer, be sure service is available in your area from the manufacturer. If service is only available from a third-party organization, check with owners of identical machines as to the quality of the service they have received and the availability of replacement parts.

Service contracts, offered after the expiration of the warranty, aren't cheap but they may prove less costly than time and material charges in the long run. Remember, when a printer is down, there's no hard copy output from your computer system.

Many printer manufacturers offer carry-in service for their less expensive models. The Centronics Models 730 and 737, which cost less than $1000, are typically serviced this way. After the warranty expires, the carry-in service charge is a flat fee which includes parts and labor. If a carry-in service department is not located nearby, however, manufacturers accommodate ship-in services.

Printer Comparison Chart

COMPANY	MODEL	PRICE	CHAR FORM	COLUMNS	KSR/RO	PRINT SPEED	PAPER TRANSPORT	INTERFACE	CHAR SET	GRAPHICS	OPTIONS OR FEATURES
Anadex	DP8000	$1,125	Dot Matrix	96	RO	112CPS	Tractor STD	RS232 or Parallel	96 Char ASCII	No	Bi directional, easily replaced head
	DP8000 AP	$1,125	Dot Matrix	96	RO	112CPS	Tractor	Special for Apple II	96 Char ASCII	Yes	Same
	DP9500	$1,650	Dot Matrix	80/132	RO	200CPS	Tractor	RS232, 20MA or Centronics	96 Char ASCII	Yes 72x75 Dots	
	DP9501	$1,650	Dot Matrix	132/220	RO	200CPS	Tractor	RS232, 20MA or Centronics			
Apple	Silent type	$ 635	Thermal Non-impact	40	RO		Friction Feed	Apple			Needs special paper
Anacom	150	$1,350	Dot Matrix	132	RO	150CPS	Pin feed or Friction	RS232 or Parallel	96 Char ASCII	No	Can print to 136 characters
Axiom	IMP1	$ 791	Dot Matrix	80-96-132	RO	100CPS	Friction Feed	RS232, 20MA or Parallel	96 Char ASCII	No	
	IMP2	$ 798	Dot Matrix	80-96-132	RO	100CPS	Tractor	RS232, 20MA or Parallel	96 Char ASCII	No	Apple, TRS-80, PET, 1EE-488 interfaces available
Centronics	MICRO P1	$ 349	Non-Impact Electro Chem	40	RO	150LPM	Friction Feed	Parallel	90 Char ASCII	No	Uses special paper
	700	$1,460	Dot Matrix	132	RO	69CPS	Friction-Std Tractor-Optional	Parallel	64 Char ASCII	No	96 Char ASCII optional
	701	$1,700	Dot Matrix	132	RO	60CPS	Friction Feed or Tractor	Parallel	64 Char ASCII	No	96 Char ASCII optional; bi-directional-std.
	702	$2,660	Dot Matrix	132	RO	120CPS	Tractor	Parallel	96 Char ASCII	No	Bi directional 9x7 matrix
	703	$2,965	Dot Matrix	132	RO	180CPS	Tractor	Parallel	96 Char ASCII	No	
	704	$1,795	Dot Matrix	132	RO	180CPS	Tractor	RS232C	96 Char ASCII	No	
	730	$ 795	Dot Matrix	80	RO	100CPS	Pin Feed, Friction Feed	Parallel	96 Char ASCII	No	
	737	$ 995	Dot Matrix Lett Quality	80	RO	100 CPS	Pin Feed, Friction Feed	Parallel	96 Char ASCII	No	Letter quality serial int. opt.
	779	$1,485	Dot Matrix	80	RO	60CPS	Friction Feed Std.	Parallel	64 Char ASCII	No	Tractor optional
	761	$1,865	Dot Matrix	132	KSR	300Baud	Tractor	Serial	64 Char Std.	No	96 Char ASCII Optional
	753	$2,965	Dot Matrix								
Base 2	800MST	$ 699	Dot Matrix	80-132	RO	100CPS	Tractor	RS232, 20MA or Centronics Parallel	96 Char ASCII	No	Optional 11,920 Buffer
C. Itoh Co.	Comet I	$ 995	Dot Matrix	80	RO	125CPS	Pin Feed	Parallel or RS232	96 Char ASCII	No	Bi directional, universal power supply, 2K buffer
	Comet II	$1,290	Dot Matrix	136	RO	125CPS	Pin Feed	Parallel or RS232	96 Char ASCII	No	Bi directional, universal power supply, 2K buffer
	Star Writer I	$2,380	Daisy Wheel	132	RO	25CPS	Friction Feed	Parallel or RS232	Changeable wheel	No	Tractor optional uses Diablo print wheels
	Star Writer II	$2,898	Daisy Wheel	132	RO	45CPS	Friction Feed	Parallel or RS232	Changeable wheel	No	Tractor optional uses Diablo print wheels
Diablo Systems	KSR1640	$3,195	Daisy Wheel	132	KSR	45CPS	Friction	RS232	Changeable wheel	No	Uses plastic wheels, tractor optional
	KSR1650	$3,295	Daisy Wheel	132	KSR	45CPS	Friction	RS232	Changeable wheel	No	Uses metalized wheel, tractor optional
	RO630	$2,430	Daisy Wheel	132	RO	25CPS	Friction	RS232	Changeable wheel	No	Uses either metal or plastic wheel, tractor optional

Printer Comparison Chart

COMPANY	MODEL	PRICE	CHAR FORM	COLUMNS	KSR/RO	PRINT SPEED	PAPER TRANSPORT	INTERFACE	CHAR SET	GRAPHICS	OPTIONS OR FEATURES
Data Royal	1PS5000	$1,110	Dot Matrix	80	RO	125CPS	Tractor	Serial and Parallel	96 Char ASCII	No	Quiet cover
	1PS7000	$2,295-2,860	Dot Matrix	132	RO	150CPS	Tractor	Serial and Parallel	96 Char ASCII	No	Expandable buffer
Data Products	MI120	$2,225*	Dot Matrix	132	RO	120CPS	Tractor	Parallel	96 Char ASCII		Compressed or expanded printing
	M200	$2,570* *EOM Prices	Dot Matrix	132	RO	340CPS	Tractor	Parallel	96 Char ASCII		Optional status display
Datasouth	DS180	$1,595	Dot Matrix	132	RO	200 LPM	Tractor Feed	RS232 or 20MA or 8-bit Parallel	96 Char ASCII	No	Non-volatile memory for settings
DIP Inc.	MOD81	$ 499	Dot Matrix	40-80	RO	100CPS	Friction Feed	RS232 or Parallel	96 Char ASCII	No	
	MOD84	$ 795	Dot Matrix	40-80	RO	100CPS	Tractor Feed	RS232 or Parallel	96 Char ASCII	No	3K buffer available
	MOD85	$ 895	Dot Matrix	80-132	RO	100CPS	Tractor	RS232 or Parallel	96 Char ASCII	Yes	x-on x-off for RS232
Digital Equipment (DEC)	LA34	$1,450	Dot Matrix	132	KSR or RO	30CPS	Friction Tractor opt.	RS232			
	LA36	$2,695	Dot Matrix	132	KSR or RA	30CPS	Tractor	Parallel or 20MA or RS232 opt.	96 Char		
	LA120	$2,750 (KSR) $2,700 (RO)	Dot Matrix	132	KSR or RO	120CPS	Tractor	20MA or Parallel RS232 optional			
Eaton LRC	7000t40	$ 425	Dot Matrix	40	RO	125CPS	Friction Feed	Parallel	Upper Case	No	3 line buffer opt.
	7000t64	$ 443	Dot Matrix	64	RO	125CPS	Friction Feed	Parallel	Upper Case	No	
Epsom American	MX80	$ 645	Dot Matrix	40-80	RO	80CPS	Tractors	Parallel TRS-80, Apple			Letter quality printing TRS-80 compatible
	TX80	$745	Dot Matrix	40-80	RO	125CPS	Tractors	Parallel TRS-80, Apple	96 Char	Yes 64 spec. characters	Vertical forms control
General Electric	Terminet 2030	$1,495 $1,420-RO	Dot Matrix	80-132	KSR RO	30CPS	Friction Pin Tractors	RS232	96 Char ASCII	No	Numeric cluster, tractors, integral modem, text editor, extended buffer
Heath	H14	$ 595	Dot Matrix	80-96-132	RO	30CPS	Tractors	RS232C or 20MA	96 Char ASCII	No	Selectable baud rates from 110 to 4,800
Howard Ind.	Ty-printer 221	$2,850	Daisy Wheel	132	KSR	30CPS	Friction Feed	RS232	Changeable	No	Intelligent word processing; also can be used as typewriter
Integral Data	Paper Tiger 460	$1,394	Dot Matrix	80/132	RO	150CPS	Tractors	RS232C or Parallel	96 Char ASCII	Yes 84x84 Dots	Automatic text justification, proportional spacing, Hi-Res graphics
	Paper Tiger 445	$ 894	Dot Matrix	80/132	RO	198CPS	Tractors	Parallel or RS232C	ASCII	Option	Dot plot option, Serial Option
	Paper Tiger 560	$1,695	Dot Matrix	132-220	RO	198CPS	Tractors	Parallel or RS232 (option)	96 Char ASCII	Yes: High Resolution	Dot plot high res. graphics Std. -letter quality, bi directional
Lear Siegler	300 Ballistics	$2,045	Dot Matrix	132	RO	180CPS	Tractor	Serial or Parallel	96 Char ASCII	No	
Malibu Electronics	165	$2,295	Dot Matrix	132	RO	165-198CPS	Tractors	RS232C Centronics Apple	96 Char ASCII	Yes: High Resolution	Type 2 fonts plus high hi. resolution graphics
	200	$2,995	Dot Matrix	132	RO	165CPS 42CPS	Tractors	RS232C or Parallel	96 Char ASCII	No	Dual print models high speed and letter quality
MPI	88G	$ 749	Dot Matrix	80/132	RO	60-180CPS	Tractors or Roll Paper	RS232C or Centronics Par.	96 Char ASCII	Option	Letter quality switch or software selectable

(continued on page 68)

(continued from page 67)

COMPANY	MODEL	PRICE	CHAR FORM	COLUMNS	KSR/RO	PRINT SPEED	PAPER TRANSPORT	INTERFACE	CHAR SET	GRAPHICS	OPTIONS OR FEATURES
NEC	5510	$3,055-4,255	Print element thimble	132	RO	55CPS	Friction Feed	RS232	Changeable	No	Tractors optional
	5520	$3,415-3,615	Print element thimble	132	KSR	55CPS	Friction Feed	RS232C	Changeable	No	Tractors optional bottom feed opt.
	5530	$3,055-4,255	Print element thimble	132	RO	55CPS	Friction Feed	Parallel	Changeable	No	Tractors optional
Microtek	MT80	$ 795	Dot Matrix	40-120	RO	125CPS	Tractor	RS232C Parallel	96 Char ASCII	No	1 year warranty
Okidata	Micro line 80	$ 475	Dot Matrix	80/132	RO	80CPS	Friction and Pin Feed	Parallel	96 Char		Tractor Feed opt.
	Micro line 82	$ 595	Dot Matrix	80/132	RO	180CPS	Friction and Pin Feed	RS232 Parallel	96 Char ASCII		Tractor optional, bi directional
	Micro line 83	$ 895	Dot Matrix	132	RO	120CPS	Tractor	RS232 Parallel	95 Char ASCII		Bi directional-uses up to 15 in. paper
	SL300	$3,995	Dot Matrix line printer	132	RO	300 line per minute	Tractor	Parallel	96 Char ASCII	Plot	Software selectable fonts, oversize char, prints bar codes
Qume	Sprint 5/45	$3,137	Daisy Wheel	132	RO	45CPS	Friction Feed	RS232C and Parallel	Changeable	No	Tractor Cut sheet feeder
	Sprint 5/45	$3,537	Daisy Wheel	132	KSR	45CPS	Friction Feed	RS232C or Parallel	Changeable	No	Tractor Cut sheet feeder
	Sprint 5/55	$3,364	Daisy Wheel	132	RO	55CPS	Friction Feed	RS232C or Parallel	Changeable	No	
	Sprint 5/55	$3,764	Daisy Wheel	132	KSR	55CPS	Friction Feed	RS232C or Parallel	Changeable	No	
	Sprint Wide-track	$4,315	Daisy Wheel	240	RO and KSR	55CPS	Friction Feed	RS232C or Parallel			
Radio Shack	Quick Printer II	$ 219	Non-Impact Electro-Thermal	16-32	RO	120 lines per min.	Friction Feed	RS232 or Parallel Radio Shack TRS-80	Upper Case	No	Uses aluminum coated paper 2 3/8 wide
	Line Printer V	$1,860	Dot Matrix	132	RO	120CPS 160	Tractor	TRS-80 Mod. I, II, III	96 Char ASCII	No	Print stand optional
	Line Printer VI	$1,160	Dot Matrix	132	RO	100CPS	Tractor	TRS-80 Mod. I, II, III	96 Char ASCII	Spec. Graphic Char	Prints Nx9, bi-directional, self-test, stand opt.
	Line Printer IV	$ 999	Dot Matrix Letter Qual	80-132	RO	50CPS	Friction Feed or Pin Feed	TRS-80 Mod. I, II, III	96 Char ASCII	No	Same as Centronics 737 for TRS-80
	Daisy Wheel II	$1,860	Daisy Wheel	136	RO	43CPS	Friction Feed	TRS-80 Mod. I, II, III	Changeable	No	Tractor optional, proportional spacing wheel
Sanders Media	Media 12/7	$4,395	Dot Matrix infinite	13.2 in. print line	RO	1 pass, 120-260 CPS; 4 pass, 10-50CPS	Friction Feed	RS-232C or Parallel (Centronics)	Multi-type faces	No	Infinite matrix, either fast Dot Matrix or letter quality
Texas Instruments	743	$1,195	Electro thermal non-impact	80	KSR	30CPS	Friction Feed	RS232 or 20MA TTY	96 Char ASCII	No	Apl. option, R.O. option, answerback memory
	765	$2,995	Electro thermal non-impact	80	KSR	30CPS	Friction Feed	RS232C or built-in acoustic coupler	96 Char ASCII	No	Bubble memory storage up to 80K, dual communication ports
	763	$2,695	Electro thermal non-impact	80	KSR	30CPS	Friction Feed	RS232C or 20MA	96 Char ASCII	No	Bubble memory 20K up to 80K, internal modem
	810	$1,895	Dot Matrix	132	RO	150CPS	Tractor	RS232C	64 Char ASCII	No	96 Char ASCII optional, expanded characters opt. compressed print optional
	820	$2,165	Dot Matrix	132	KSR	150CPS	Tractor	RS232C Baud Rates 110-9600	95 ASCII Char	No	Terminal stand option, 20MA opt., APL opt.
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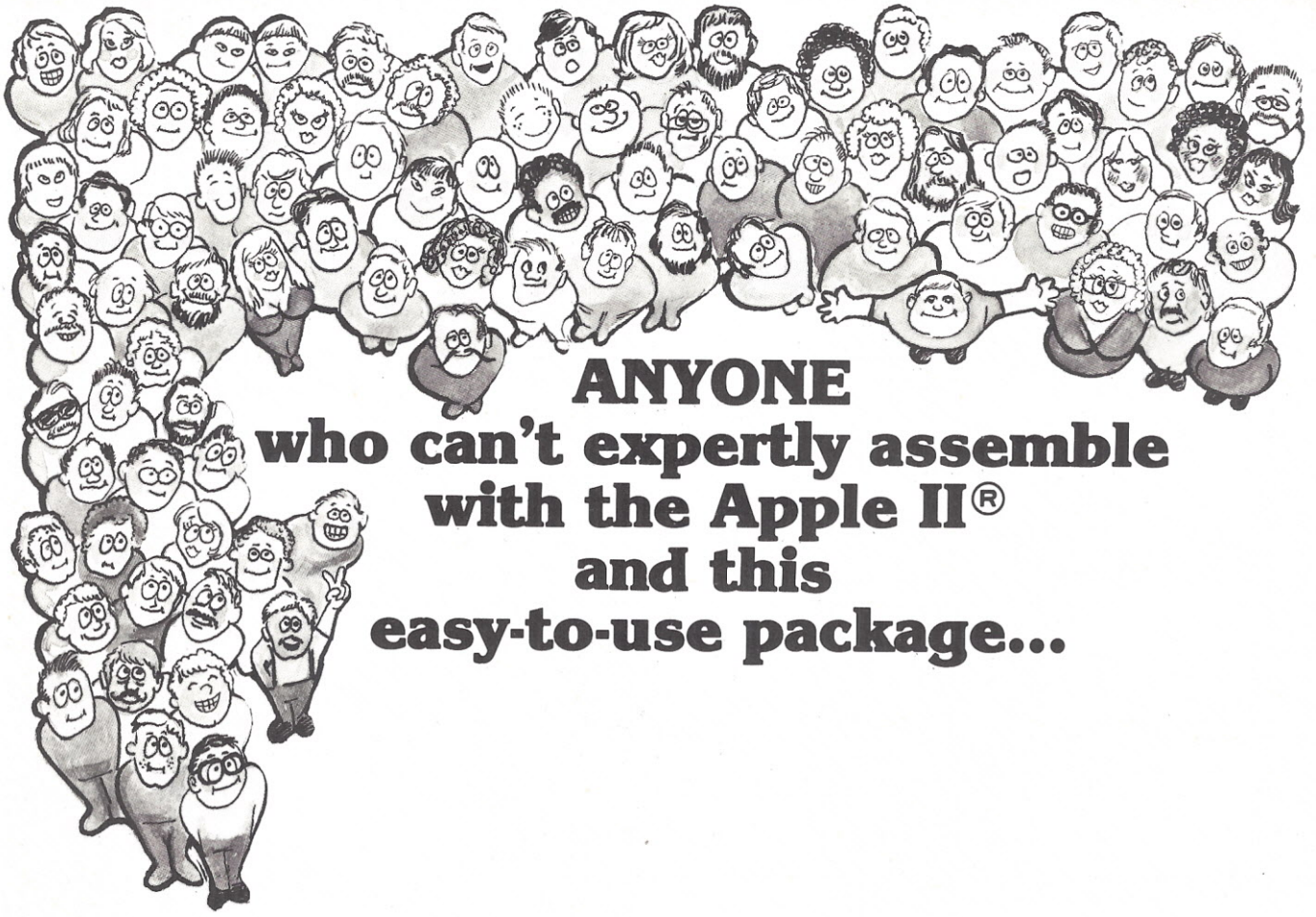

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CIRCLE 22

The Eleventh North American Computer Chess Championship

Part II

BY EVAN KATZ

Round 1 — October 26

In *Belle* vs. *Mychess,* the small machine gobbled a pawn which it should not have eaten, and then was outplayed and "outplyed," getting mated in under thirty moves. *Belle,* with by far the largest opening library, remained in book for ten moves even though *Mychess* was out of book after several moves! The moral of the game was to castle thy king; *Mychess* never did.

Ostrich, in its game with *Chaos,* goofed on move five with Nxc6. This same mistake in the Sicilian, letting black recapture to the center while gaining the b-file, was made by *Chess 4.7* in its famous match vs. Levy, who would intentionally create a position where 4.7 could blow it. Beginning programmers should note that the move *does* give black an isolated pawn; it's tough to balance positional factors! When *Ostrich* followed with passive, imprecise play, *Chaos* smothered it until Monty Newborn resigned for his program on move 24.

Cray Blitz vs. *Cube* was unique in that it was the "highest-powered" chess game to date. The two combatants were performing a total of 160,000,000 instructions per second! The game ended abruptly, however, when *Cube* encountered uncorrectable machine trouble and had to resign, admittedly in a bad position. *Blitz's* tenth move (0-0) was made based on an eight-ply search taking 55 minutes (while *Cube* was down). It was *Cube*'s first tournament and things did not run smoothly. The program also suffered from a fifteen second communications delay as data from Nashville first went to a toll-free number then to an Apex, to a Cyber 175, to a live concentrator and then finally to the Cray. Lloyd Lank, *Cube's* author, promises to be back next year with a better program.

Challenger chose to play positionally vs. *Bebe*'s Sicilian Dragon. David Levy commented that *Bebe* exhibited a "deep understanding" of the Sicilian through move 15. After some indecisive moves, it was later able to win a pawn but could make nothing out of it. *Challenger* examined six ply after queens were exchanged, and examined eight on move 28 in 4:24! And to think that *Sargon* could only get three last year! *Bebe,* which was searching seven ply, allowed 16 seconds for the I/O of moves, a typical "fudge factor" for slow human execution. The combatants reached a drawn endame at move 55.

Awit, which played 1. b2, 2. Bb2, 3. e3, 4. Nf3, the two times it had white, rolled over *Clash,* mating it in 18 moves. Not only did *Clash* suffer from a lack of ply (only three) throughout the tournament, but it only castled its king once and would often move minor pieces before others were fully developed! Give credit to Chris Peters (its programmer), however. *Clash* was undergoing its first test and will surely enjoy quantum improvements in the years to come.

Mychess began well vs. *Bebe,* playing aggressively against its Dragon and, after 17 moves, *Mychess* was up a pawn with a sound position. On move 18, though, it pushed a "passed" pawn in front of its king followed by another bad pawn push at move 25. But on move 33, *Bebe* found a wonderful combination, winning two pawns and exposing the white king. Poor *Mychess* tried to minimize losses, though, and *Bebe* found a mate in six. It was a tough game for *Mychess* to lose, having achieved a won game and then getting outplyed.

Blitz vs. *Belle,* the most exciting game of the round, was a Two Knights Defense. David Levy noted that although in a human chess game the player who offers a pawn for the attack usually does better, computers do better when defending with an extra pawn. When finally out of book, *Blitz* rerouted its queen with 18. Qe 1 and 19. Qh4 just as Levy recommended; who says machines can't play positional chess? *Blitz* then came upon (saw first) a nice combination, loosening up the black king's pawn cover and winning the exchange. *Belle* achieved counterplay, however, and came upon a combination winning back the exchange and coming up a pawn ahead. Bob Hyatt lamented that if he had been able to convert *Blitz* into assembler for this tournament, it would have gotten the extra ply, avoiding the loss and possibly winning the game and the entire competition. *Blitz* followed with passive play and, after it put its king in the corner, *Belle* found an endgame mate.

Fred Swartz and Ken Thompson (in front of terminal) await Belle's next move in its victory against Chaos.

Chaos won a pawn and achieved a strong position as white in an Exchange Gruenfeld vs. *Awit*. It marched its king to the center upon reaching the endgame and won with relative ease. One should remember that both programs are selective and only examine certain moves.

Ostrich played the Exchange Ruy Lopez vs. *Challenger* and soon regretted it. By playing 10. Nc3, a typically good developing move, *Ostrich* allowed *Challenger* (to gain the bishop pair and to give) it doubled, isolated pawns on an open file in a game without queens already. *Challenger* then beautifully took the seventh rank, marched its king to the center and squeezed a befuddled *Ostrich* to death.

Cube outplyed *Clash,* winning its queen on move 14 and mating eighteen moves later.

Round 3 — October 27

Before round three, this writer gave *Belle* a "cute" problem to solve: White has a rook on al, a king on el and pawns on a2 through a7. Black has a king on a8. White to play, mates in eight with 1. 0-0-0!, 2. Rd8, 3.Rd7, 4. Rd6, 5. Rd5, 6. Rd4, 7. Rd3, 8. Ra3++! Granted that the position is impossible due to the fact that a pawn may only move diagonally to capture. *Belle,* without knowing that it was looking for a mate, found the solution in eight seconds! It "smelled" the win in eight but only saw it in twelve. No human to my knowledge, even when given that white may castle, has come close to this. *Belle's* eight second solution is slow, considering how move ordering in violently opposed to forcing your opponent to capture your pawns!

Clash, having held its own for 17 moves vs. *Ostrich* walked into a knight fork losing the game.

Belle vs. *Chaos,* (the Word Champion vs. the runnerup) was a fine Round Three contest. *Belle,* white in a c3 Sicilian, controlled the center, but *Chaos* could not make hanging pawns out of it. *Chaos* achieved a nice position with two rooks and two bishops against a queen, rook and knight, but could not play incisively enough. *Belle,* aggressive as always, broke through and mated *Chaos* before the end of the first time control.

A complete absence of aggressive play between *Awit* and *Challenger* led to a dull game for the first 29 moves. On move 30, *Challenger* incorrectly decided to take three pawns for a piece; it only got two. The Spracklens had forgotten to suppress the higher value given to passed pawns before the endgame and didn't discover the fact until too late. But *Challenger* then outplyed *Awit,* winning back the piece and the game.

Blitz won greater mobility than *Bebe* in their Sicilian battle, and pushed through in the center winning in 42 moves.

Cube and *Mychess* played one of the weirdest games of the tournament looking not like bad programs, but human novices. *Cube* allowed its king to be caught in the center, but *Mychess* could only win a pawn. With its move 33. (Qg5+), *Mychess* predicted: 34. Kc2 Re5, 35. Be4 Ne3, 36. Rd7 Kg8, 37.Bxb7 Nxg4, a reasonable continuation (if white could not mate in two moves). *Cube* crashed after move 37. (Nc3+) and lost on time while contemplating the obvious 38. Kc2. *Mychess,* of course, had predicted this move and had 55 minutes to think up its response which would have been 38. Qe7, predicting 39. Qf4 Qe4+, 40. Qxe4 Nxe4, 41. Kd3 Nf2+, 42. Kxd4 Nxg4, also a reasonable continuation. It would have been a very interesting game if *Cube* could have continued.

Round 4 — October 28

Before the start of the last round, a review of the ICCA (International Computer Chess Association) Triennial Meeting that took place in Linz was presented. Ben Mittman, recently elected President, announced that the ICCA now has over 300 members; each receives the *ICCA Newsletter,* published several times a year. Monty Newborn and Ken Thompson had been elected vice president and secretary/treasurer, respectively. Dues are $10.00 (U.S.) for one year membership. Inquiries should be sent to Ken Thompson, Bell Telephone Laboratories, Room 2C, 423 Murray Hill, New Jersey 07974.

Mychess never really strained itself in its game with *Clash.* In fact, the most interesting moments of the contest occurred when the outcome was obvious to all. Dave Kittinger was using the same data structure in *Mychess* as he always had, and *Mychess* will therefore not allow more of a piece than is originally on the board. Last year, when *Mychess* promoted to a bishop, Barend Swets of BS'66'76 had to read reams of code to find out how he could enter a bishop instead of a queen! This year, when *Mychess* (finally) opted for a rook on two occasions, *Clash* kept playing as if the rooks were queens. Chris Peters' rationale was that, since his program assumed the more powerful piece, it was actually making "extra-legal" moves!

Bebe outplayed then outplyed

Awit's Najdorf Sicilian with the second shorted mate of the tournament.

A dry draw between *Ostrich* and *Cube* was significant only as being the tournament's second draw. When the machines start drawing 75% of their games instead of 10%, we'd better start worrying!

For all intents and purposes, the *Chaos-Blitz* game was for second place with the loser taking fifth place on account of the Swiss Gambit. *Chaos* maintained its spacial advantage out of the Queen's Gambit Declined and was able to double rooks on the b-file (leaving book on move 17). *Blitz* had two isolated pawns and only fair piece coordination, but its a-pawn was passed. But during the crucial middlegame, unknown to Bob Hyatt, *Blitz'* priority had been reduced and the program was only getting a fraction of the CPU time instead of the 100% it was supposed to. Combined with sound play by *Chaos, Blitz* was done in. But Hyatt will be back next year with an assembled version of *Blitz* and a larger Cray machine. Taking general improvements into account as well, *Blitz's* eight ply or more search next year will be a very tough contender.

Challenger vs. *Belle*—a rematch from last year when *Sargon* declined a draw with *Belle* in the final round and lost. It did this because its "contempt factor" told it to forgo a draw unless down half a pawn. Although this writer suggested to the Spracklens quite strongly that they implement a contempt factor which could be set before each game according to the strength of the opponent, who would have thought that *Sargon* would be able to take a draw from *Belle* in the first place? Having goodnaturedly teased the Spracklens on and off this year about all the publicity which *Sargon* would have received if it had drawn *Belle*, this writer was surprised when that old, inflexible half pawn contempt factor remained for this year's ACM. Again, though, who would ever think that lightning would strike twice? Naturally, it did.

After 17 moves of an always-exciting Open Ruy Lopez, *Challenger* broke things open with 18. Nxh7! But *Challenger* did not have enough pieces to attack with on the kingside and "only" had a draw by repetition which it declined by not playing 26. Nh7+. *Belle* soon improved the position of its pieces and did *Challenger* in. Wouldn't Fidelity have loved to advertise that its *Challenger* managed to gain a draw with the World Computer Chess Champion?

The Speed Tournament

The speed tournament, with few exceptions, was a matter of computer strength right down the line. *Clash,* seeing only one ply ahead, was only able to draw by lucking into repetition of position. Even though *Challenger* was seeing three or more ply further, it horizoned pieces to *Clash,* which then accepted a draw much to Chris Peters' delight. Chris felt that it would still have lost, even up two pieces. It is gratifying to realize that, due to all the progress in computer chess, the worst programs of today or the best programs of today given five seconds at most, could have beaten the championship programs of ten years ago. □

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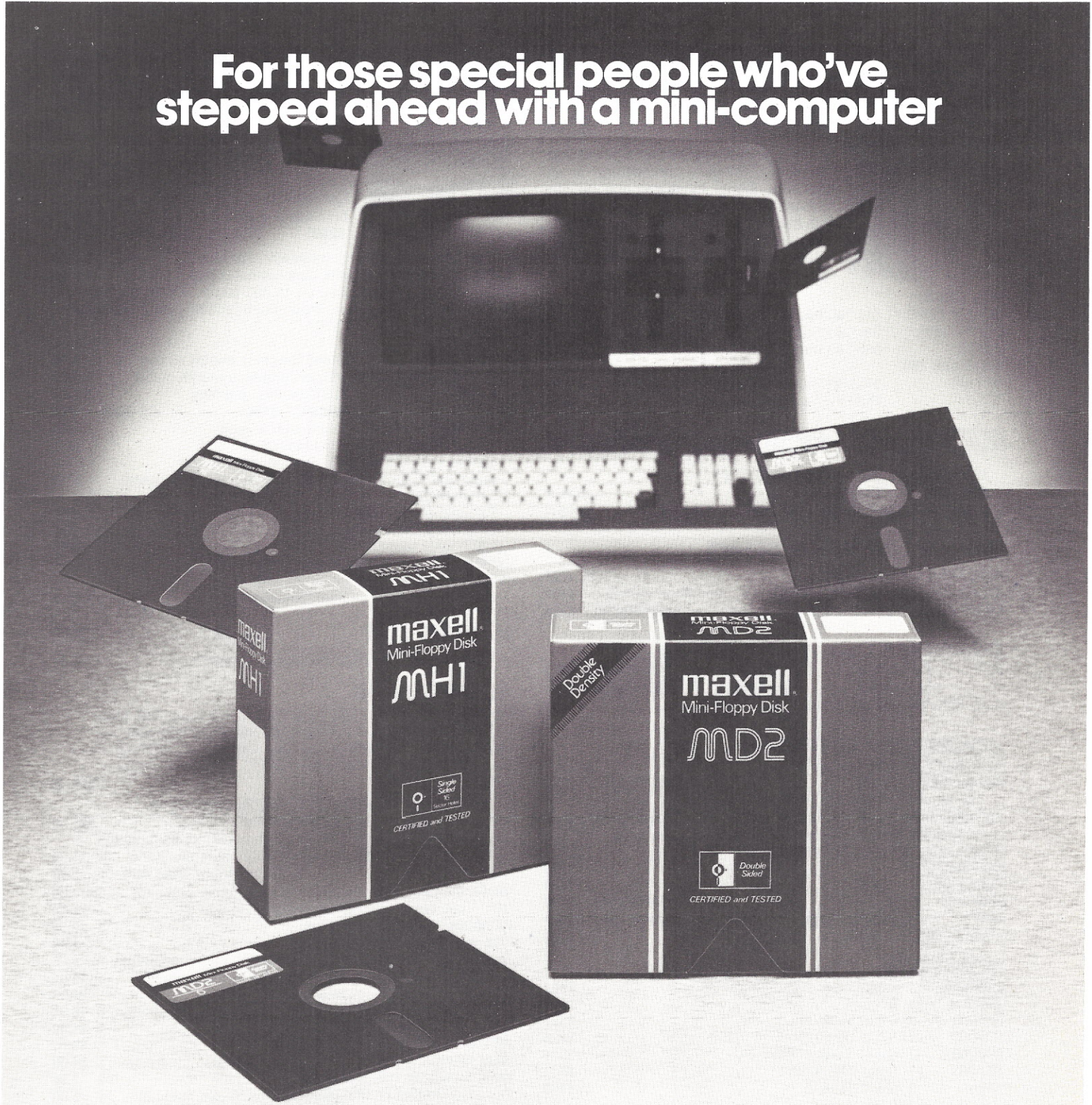

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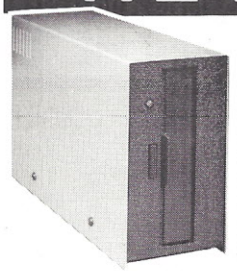

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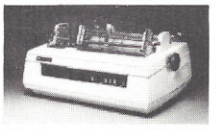

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CIRCLE 24

Inside the TRS-80 Color Computer

BY RALPH BURRIS

In our first look at the TRS-80C (*Personal Computing*, February, 1981,) a sense of wide-eyed enthusiasm may have been detected. I'm happy to report that this feeling has diminished only slightly. In fact, it appears that some of our uneducated guesses were well-founded—there's a whole lot more to this animal than meets the eye.

Aiding your memory

It turns out that the TRS-80C really needs a bigger brain than what is actually supplied—about 12K more, to be exact. So, after a few attempts to get Radio Shack to supply the necessary upgrade (which, as of this writing, they were still unable to do) I grabbed a screwdriver, and, throwing caution and warranty to the wind, opened the unit up.

Inside the case is a beautifully laid-out collection of ICs and other components—all of which, I may add, bear the Motorola imprint. Besides the Motorola logo, a few of the chips also bear the notation "c '80 Tandy," among which are the Color BASIC's ROMs, the row of eight, 4K memory chips and, surprisingly, the MC6809E itself.

The 4K memories are tucked neatly in sockets making it a simple matter to replace them with a 16K set. You will find two small, and clearly-labeled jumpers (4K on one pair, 16K on the other), which are equipped with easily-switched caps. The 4K memory chips were gently pried up and replaced with MC4116's.

The folks at Motorola have informed me that another set of 16K chips may be piggy-backed on top of this group to produce 32K internally, but I haven't tried it as yet. The procedure seems simple enough—all pins except pin number 4 are connected to their existing counterparts on the board. All of the number 4 pins are then connected together on a single wire, which is looped through a ferrite coil (to reduce noise), and attached to pin 35 on the SAM (Synchronous Address Multiplexer) chip. (Of course, I don't recommend doing either of these things to *your* TRS-80C—at least until the warranty has expired, as it will cause some consternation at your repair center if anything has gone wrong.)

TRS-80 Hardware

A lot of people have gotten pretty far with the Model I without ever being bothered with how the machine works. The truth is that many people can probably enjoy a long and productive life of programming the Z80-based system with only a minimal knowledge of how things get around inside the TRS-80. The TRS-80C, on the other hand, has a lot of interesting features which merit a deeper look in order to fully appreciate the machine's power and usefulness. The TRS-80C is actually a group of computers tied together, each of which performs a specialized function in the machine.

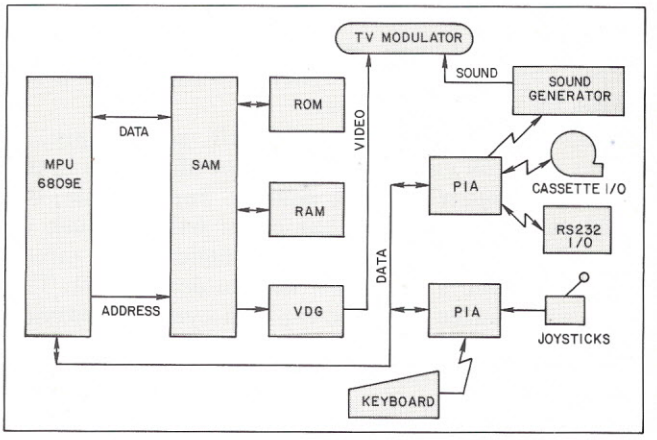


Figure 1. A block diagram of the TRS-80 Color Computer.

The MC6809E

The "boss" of the TRS-80C is Motorola's 6809E MPU (Micro Processing Unit). This chip, like the Z80 in the Model systems, runs the whole operation and is the clearing-hourse for all the data operations inside. The Z80 has very little help in its operations in the Model systems, although a little help is offered by the video interface. Other than that, the Z80 is pretty much a one-man show.

The MC6809E, on the other hand, has a lot of "helpers" which take care of various chores, leaving the MPU free for more data manipulation. This combination allows the TRS-80C to have a lot of very powerful features, including different clock rates, different screen sizes, and different video modes, all of which are software selectable.

The MC6809E was designed with more power and better data handling, and is really the "older brother" of the 6809. The main difference seems to be that the "E" series features an outboard clock, where the 6809 has a built-in clock. Before we delve into the library of MC6809E instructions, let's take a brief look at the "helpers" in the system.

Synchronous Address Multiplexer

The SAM is a fairly new item on the market, and the TRS-80C is one of the first systems to use this unique product. It serves as a sort of "broker" or

agent for the MC6809E, and is responsible for finding items such as addresses and hardware conditions requested by the MPU. Additionally, the SAM provides the necessary clock pulses to keep the MPU alive and well, services the memories with "refresh" signals (which keep the data alive), and translates instructions for the other devices.

According to Motorola, the SAM provides: transparent refresh, single crystal timing, register-programmable VDG addressing modes, VDG offset (0-64K), RAM size, Bank switching and MPU rate, system "device selects" decoding, and DMA (direct memory access) mode. SAM also allows RAM (or ROM) addressing of 96K bytes, single (+5 volt) power supply, and easy synchronization with other SAMs for even more power.

What does all this mean? Well, put simply, it means that you can have a whole lot of options in the system, all under software control. For example, the SAM can be told that it has either 64K dynamic or static RAM, or 16K or 4K of dynamic RAM, mixed with ROM, and it will know how to deal with it. The clock rate can be adjusted (refresh cycle) to provide 1.8 MHz, 0.9 MHz, or a combination of both, which allows mixing of slow RAM with fast ROM or vice versa. It also allows an instant switch between one of two 32K "pages" of memory occupying the address range of $0000 to $7FFF (I'm told that the TRS-80C doesn't use this or the DMA features).

The SAM is hard wired to a block of memory locations in the TRS-80C, and its registers are programmed by writing data to those addresses. Odd locations "set" the registers, even locations "clear" them.

Video Display Generator

The MC6847Y, (the "Y" means it is an interlace model for standard TV output, as opposed to a video monitor output) takes care of all the video display chores. In the TRS-80C, there are many possible screen combinations ranging from the normal "alphanumeric" display of 32 characters X 16 lines all the way up to 256 X 192 "pixels." The SAM takes care of telling the VDG what it wants and where the screen is, and the VDG takes it from there, scanning and displaying the screen data as required. In contrast to the Model systems, which have a fixed video RAM area and only two modes—graphics or alphanumeric—the VDG allows mixing of alphanumeric and graphic characters in many ways. You can even combine different letters/numbers to make up new characters.

Some of the highlights of the VDG include: internal or external ROM character generator, eight colors in various modes, 4-color alphanumerics (two sets), full video composite signal generation, selectable inverse characters in alphanumeric modes, and full graphic modes including: 64 X 64, 128 X 96, 128 X 192, and 256 X 192.

Peripheral Interface Adapters

There are two PIAs in the TRS-80C which handle keyboard input, cassette I/O and will have information waiting for the MPU when it wants it or they can deliver the data to the specified output device.

Figure 2 shows the addressing of each PIA register and which memory locations they are connected to. You can have a lot of fun poking different values into the various memory locations and watching the results on the monitor. Just keep in mind that some of these pokes will wipe out any meaningful data in memory, so don't try it if you are in the middle of anything important. In fact, some pokes (e.g., clock speed area) will put you entirely out to lunch, so you will have to shut down in order to regain control.

Play it again, SAM

There is an interesting (not to mention quite useful) arrangement in two of the PIA memory locations. An amazing range of sounds may be generated by manipulating data at location $FF20 (65312 decimal). This is referred to as "6-bit sound" and is enabled by setting bit 3 of location $$$23 (65315 decimal). Poke a 63 (decimal) into 65315, and then any value you put in 65312 will produce an analog voltage output in the range of +0.25V to +4.75V. This output can be used to create some great sound effects, as well as a variety of pleasing musical tones. The formula used to determine the voltage output is:

Voltage = (N * 0.0715) +0.25
where N = 6 bit value msb (0-63)

Try this simple BASIC program for an example of 6-bit sound:

```
10 SO=65312              Sound output address
20 POKE65315,63          Enable 6-bit sound
30 ST=4                  Start loop
40 EN=240                End loop
50 S=4                   Step value
60 FORX=ST TO            Loop sound values
   EN STEP S
70 POKE SO,X             High value
80 POKE SO, EN-X         Low value
90 NEXT
```

This program produces a low pitch of diminishing and increasing volume. Try variations of the start, end and step rates, and try making line 80 poke SO with a 0 or other value for different effects. You can also add a loop after line 90, repeating the sequence in reverse order to set even more variations.

Tones in the 6-bit program are low, because BASIC is too slow to output the sound values needed for higher pitches. Once you venture into machine language, the possibilities are unlimited.

Video display modes

The block of memory from $FFC0 (65472) through $FFC5 (65477) controls the Video Display Generator modes. Poking values in odd locations (i.e. $FFC1, $FFC3, $FFC5) causes the VDG register at that address to be SET (turned on). Values poked to even locations CLEAR the VDG register. (Remember, the VDG chip does its own thing with the information, so the value poked is irrelevant and can even be a zero.)

There is another memory location which comes into play in selecting the display mode—$FF22 (65314), which controls the VDG output. Bits 3 through 7 of this address select various conditions for the display mode, such as inverted graphics and color

select. Bits 0 through 2 of this location are used for (0) RS232 data input, (1) Single bit sound output and (2) RAM Size, so be careful of the values you put into this address. If you make sure that the value has bits 0 through 2 set, you won't run into trouble.

One other item that comes into consideration in some modes is the condition of bits 7 and 8 of the data going to the screen. As you will see, bit 7 determines regular or inverted characters, and bit 8 (as in the Model systems), indicates a graphics character.

In the following chart, the addresses in the VDG section show the lsb of each mode to write to (i.e. $FF00 + lsb). Any value shown in the "$FF22" column is poked at that address. A small "x" means "don't care" in the Data Bit column. The values all

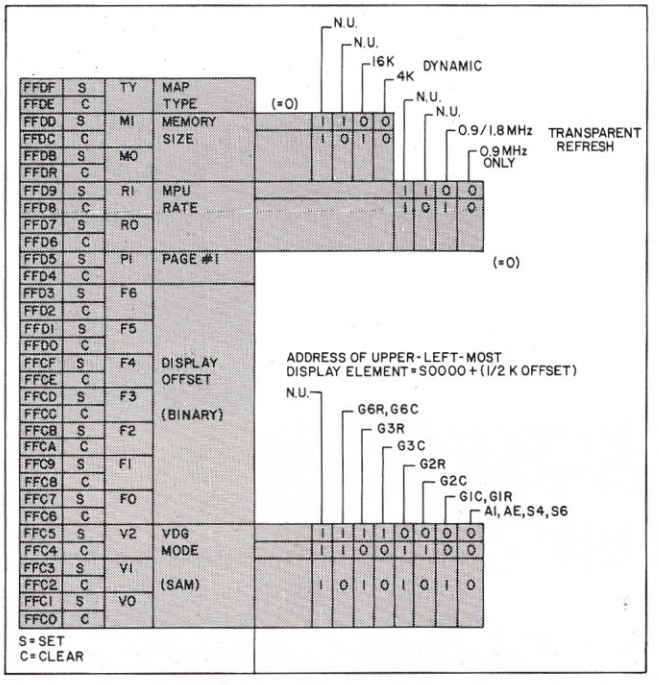


Figure 2. A memory map of the Synchronous Address Multiplexer.

have a 7 added to them to set the lower 3 bits in all cases to prevent system crashes from alteration of memory size.

VDG	(Values at $FFXX -)						$FF22		Data Bit	
MODE NAME	C0	C1	C2	C3	C4	C5	HEX	DEC.	(7)	(6)
AlphaNumerics	C0		C2		C4		07	07	0	0
AlphaInverted	C0		C2		C4		07	07	0	1
SemiGraphics 4	C0		C2		C4		07	07	1	x
SemiGraphics 6	C0		C2		C4		17	23	1	x
SemiGraphics 8	C0			C3	C4		07	07	1	x
SemiGraphics 12	C0		C2			C5	07	07	1	x
SemiGraphics 24	C0			C3		C5	07	07	1	x
64 x 64 Color		C1	C2		C4		87	135	x	x
128 x 64 Graphics		C1	C2		C4		97	151	x	x
128 x 64 Color	C0			C3	C4		A7	167	x	x
128 x 96 Graphics		C1		C3	C4		B7	183	x	x
128 x 96 Color	C0		C2			C5	C7	199	x	x
128 x 192 Graphics		C1	C2			C5	D7	215	x	x
128 x 192 Color	C0		C2			C5	E7	231	x	x
256 x 192 Graphics	C0		C2			C5	F7	247	x	x

You can create some odd situations by changing the values that you put in $FF22, some of which are quite useful and interesting (try, for example, a 255 decimal). Just be sure that the value you put there has the lower three bits set.

Bytes As Bits

The TRS-80C, unlike the Model systems, can have its screen address anywhere in memory, and the screen can vary from 512 bytes (1/2 K) all the way up to 6144 bytes (6K). The normal screen is 512 bytes long and occupies the area from $0400 to $0600 (1024—1536). To set up a new address, the SAM chip looks at addresses $FFC6 through $FFD3, and uses this memory area as the Most Significant Byte of the screen address, offset by 1/2 K.

Try to envision these 14 addresses as a 7-bit byte, with even numbers representing a zero, and odd addresses representing a one. Screen pages are assigned in 1/2 K chunks (512 bytes), so the address you may wish to use as the upper left-hand corner is divided by 512 (decimal) and the result is stored in the "screen address" area. Thus, if you want the screen to start at $3C00 (15360), as in the Model systems, the address is divided by 512 (decimal)—15360/512 = 30 ($1#). Next you would set up a pattern of 1's and 0's for $1E (msb): X001 1110 (only 7 bits). Now, starting at $FFD3 (which would be the msb of our imaginary "byte"), you poke a value into the even location if a zero, or the odd location if a one, and work your way down to $FFC6 (the lsb location).

Here's how it would work for your screen at $3C00: Address to POKE (value is irrelevant):

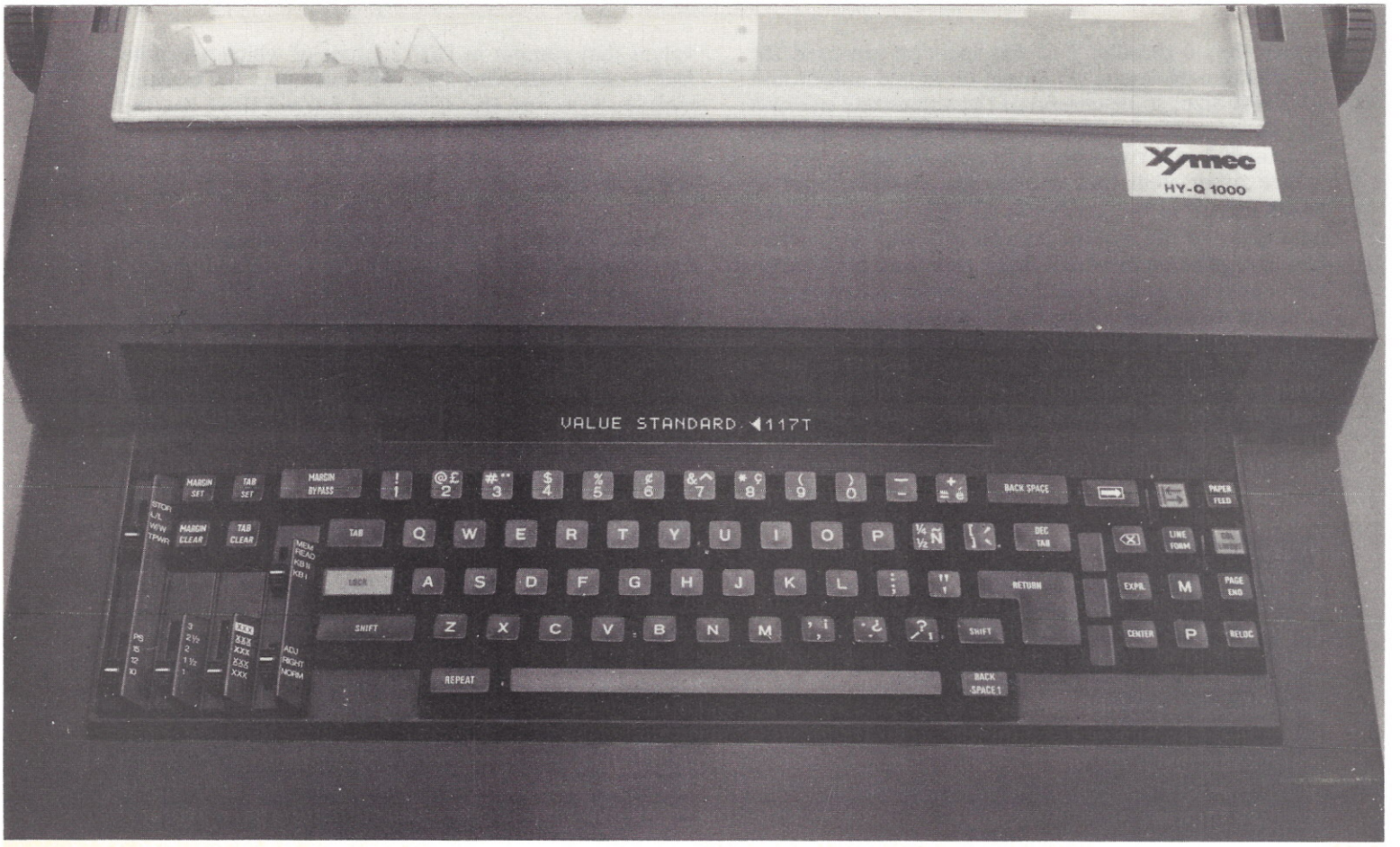
$FFXX:	D3	D2	D1	D0	CF	CE	CD	CC	CB	CA	C9	C8	C7	C6
	0		0	1		1		1		1				0= $1E

The SAM will take this value, multiply it by $0200 (512), and your screen will now appear at the same address as in the Model systems. Of course, it will be a 1/2 K screen, and will not be noticed by BASIC, because BASIC expects the screen to be at $0400. You can test its new location by poking some values in the range of 15360 to 15872 to see the new screen map. You can also change the screen size by altering the VDG mode. (If you have only 4K, the screen can be located no higher than $0200 (3584), as that is the top of RAM in the 4K system, less $0200 (512)—the smallest screen size available.)

Summing up

As you can tell from the preceding, we've tried to concentrate upon the areas in which feel the machine is different from other systems out on the market. Whether or not the TRS-80C is the machine for your needs, immediate or long term, is a question that can be answered only by you, and then only after careful consideration of the pros and cons.

Also, as mentioned earlier, it is strongly recommended you do not attempt memory modification to the machine while it is still under warranty, and in no circumstance unless you are technically qualified to do so, or know someone who is. Mistakes made while attempting a modification of this nature can prove to be costly. □



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CIRCLE 19

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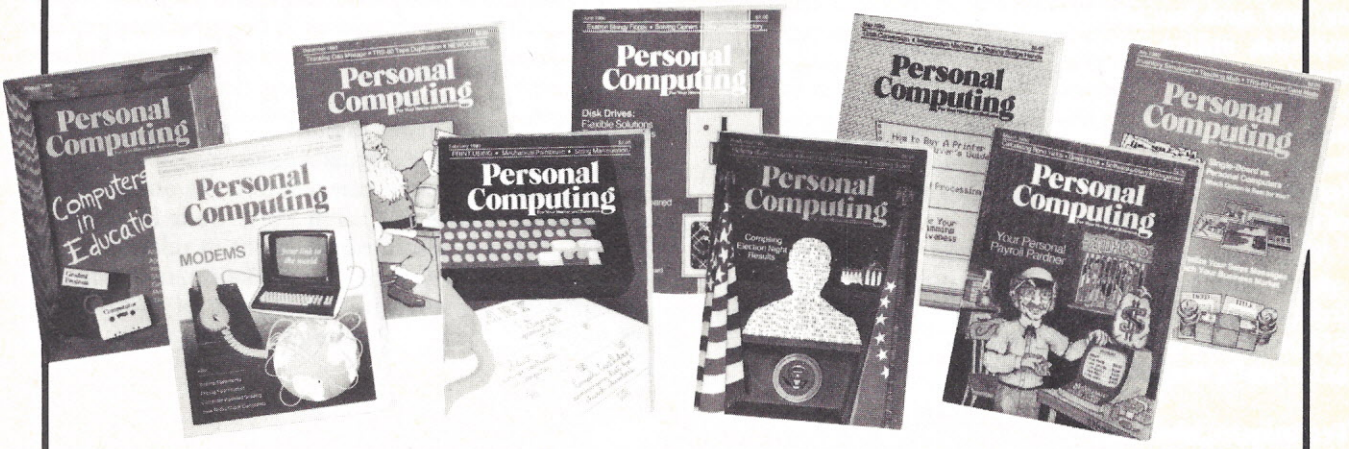

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Computer-Generated Speech: The Voice of the Future

PART I

BY GENE A FRANTZ, KATHY M. GOUDIE, KUN-SHAN-LIN

Texas Instruments, Inc.

Ever since the introduction of personal computers, people have been trying to teach them how to speak. There are many ways to give a computer a voice, and each has advantages and disadvantages. Some methods utilize digitized voice signals, require tremendous amounts of memory and have a very limited vocabulary. Others synthesize speech electronically and have a virtually unlimited vocabulary, but often sound very mechanical. Recent advances in software technology have made it possible to improve the quality of synthesized speech.

This article is the first of a two-part series dealing with speech synthesis. In it, we will deal with a general introduction to the principles of speech synthesis, a review of how speech is produced in the human, and take a look at currently available text-to-speech techniques.

Techniques abound

There are many methods currently available for synthesizing speech, and they can best be explained by dividing them into two basic categories: waveform encoding, and parameter encoding. Table 1 lists several of the more common procedures in each category. Chances are, you have already encountered one or more in some form; either in a magazine article, or in a demonstration of some hardware which is already available on the market.

(Editor's note: In May, Personal Computing's staff will discuss the latest developments in the speech synthesis field including new products from Texas Instruments, Votrax and National Semiconductor. We will also review: speech output accessories for the Apple, Radio Shack TRS-80 Texas Instruments 99/4 and Pet microcomputers; applications for these accessories; a vendor guide; future trends in the field and the significance of those trends.)

The term *waveform encoding* is used to describe the first four techniques listed in Table 1, because it best describes how the speech information is being processed. In each of the systems described, the synthetic speech signal is produced from digital information which attempts to duplicate the original analog speech waveform. The synthesis technique can describe the amplitude of each sampled data point, as in Pulse Code Modulation (PCM), or it can describe each point in relation to the previous data point as in delta modulation, or it can use a combination of these with some steps of information compression, as in the technique developed by Forest Mozer.

PCM

Pulse Code Modulation (which uses uncompressed digital data) is the simplest technique to use and to understand. It consists of converting the speech signal into digital information using an analog-to-digital converter (ADC). Once it is in digital form, it can be stored in memory and played back through a digital-to-analog converter (DAC) passed through a low pass filter (to smooth out the signal and reduce noise), amplified and fed to a speaker. The advantage of this approach is its simplicity. ADCs and DACs in both hardware and software packages are readily available and relatively inexpensive. The problem with this approach is the large amount of memory required to store the digitized analog signal.

For adequate speech reproduction, the frequency response of the system must be such that frequencies below 4,000 Hz are reproduced and frequencies above 4,000 Hz are rejected. In other words, the system must use a low pass filter with a 4,000 Hz cut-off. Note that in discussing all of the synthesis techniques, the frequency

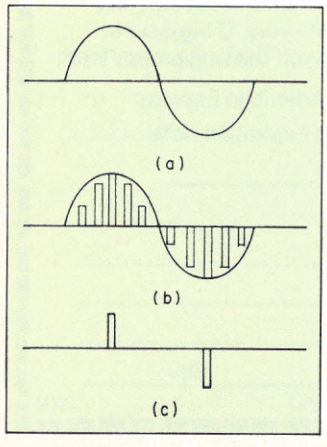

Figure 1. An analog signal (a) can be sampled periodically in such a manner that it can be reconstructed (b) into a close approximation if its original form. A sampling rate of twice the original frequency of the signal is required (c) for this process.

WAVEFORM CODING
UNCOMPRESSED DIGITAL DATA-PULSE CODE MODULATOR (PCM)
DELTA MODULATION (DM)
CONTINUOUS VARIABLE SLOPE DELTA MODULATION (CVSD)
MOZER'S TECHNIQUE
PARAMETER CODING
CHANNEL VOCODER
FORMANT SYNTHESIS
LINEAR PREDICTIVE CODING (LPC)

Table 1. Various coding techniques.

range will be assumed to be 4,000 Hz and below. There is some argument as to whether the upper bound should be 4,000 Hz, or 5,000 Hz or 6,000 Hz. But to be consistent in comparing the various techniques, 4,000 Hz will be used.

Sampling

A voice signal is converted to a digital signal by using a technique known as *sampling*. As can be seen in Figure 1, an analog signal (a) can be sampled periodically in a manner such that by retaining only the digital samples it is possible to reconstruct the original analog signal (b).

According to the well-known Whittaker-Shannon Sampling Theorem, a minimum sampling rate of twice the highest frequency in the signal to be sampled is necessary, as can be seen in Figure 1c.

In Pulse Code Modulation, assuming a 4,000 Hz upper bound in a voice signal, the sample rate would be twice that, or 8,000 samples per second. The number of bits chosen to represent each speech sample typically vary from eight to twelve, depending on the overall speech quality desired. But it is possible for as few as one bit per sample to be used and still be recognized as speech. With 8 to 12 bits being used, the resulting data rate would be 64,000 to 96,000 bits per second. In other words, one second of speech would require 64,000 to 96,000 bits of memory. Such a memory-intensive system would be too costly for general consumers.

Delta Modulation is another waveform coding technique that is used. This method attempts to compress the speech data by assuming that the analog speech signal is always either increasing or decreasing in amplitude. The typical sampling rate is 64,000 times per second. Each sample is then compared to the estimated amplitude value of the previous one. If the first value is greater than the estimated value of the latter, the slope of the signal generated by the model is positive. If not, the slope is negative. The magnitude of the slope is chosen so that it is at least as large as the maximum expected slope of the input waveform signal.

An extension of Delta Modulation can be made by allowing the slope of the generated signal to vary. This third technique is known as Continuous Variable Sloped Delta Modulation (CVSD). The data sampling rate of CVSD is typically 16,000 to 32,000 bits per second, somewhat less than the 64K rate of standard Delta Modulation. The memory saving of the latter technique is immediately evident.

The fourth waveform encoding technique to be discussed is the one developed by Forest Mozer. This method takes advantage of the fact that the waveform of a speech signal repeats itself regularly (it is periodic). It also relies on the fact that the human ear and brain combined are not sensitive to a characteristic of the waveform, known as phase. Mozer uses several steps to compress the information in the speech waveform, so that less memory can be used. They include:

1. Phase angle adjustment to obtain a time-symmetric pitch period waveform which makes one-half of the waveform redundant.
2. Half-period zeroing to eliminate relatively low-power segments of the waveform.
3. Digital compression using Delta Modulation.
4. Repetition of pitch periods to eliminate redundant (or similar) speech segments.

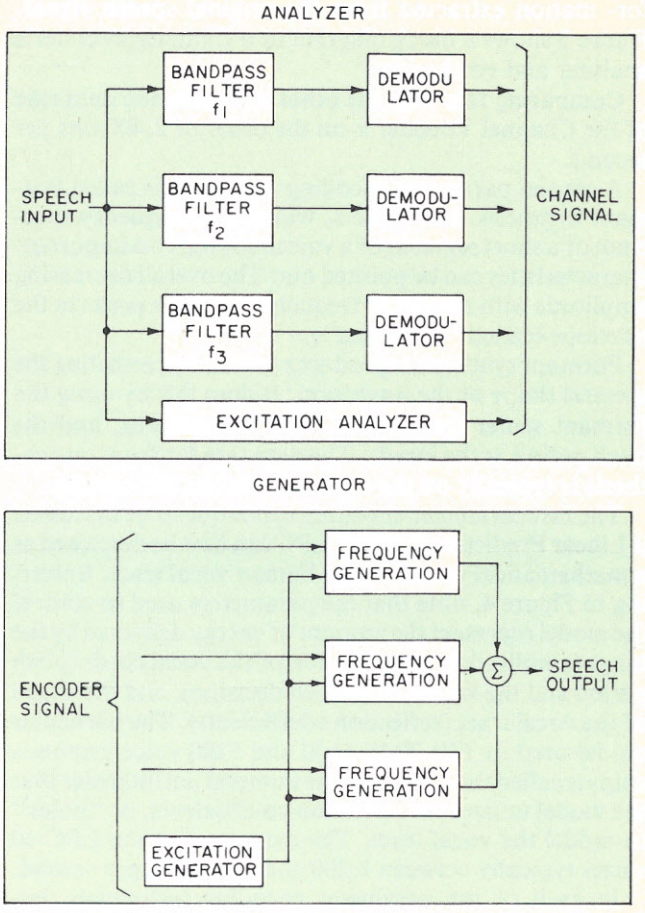

Figure 2. Block diagram of Channel Vocoder

Note that the date rate of this technique is approximately 2,400 bits per second, which is by far the best of the waveform encoded group.

Parameter encoding

In parameter encoding schemes, speech characterisitics other than the original speech waveform are used in the analysis and synthesis of speech. These characterisitics are used to control a mathematical synthesis model to create an output speech signal which is similar to the original. Note that unlike waveform encoding, there is no intention here to attempt to reproduce the original speech waveform.

For instance, the Channel Vocoder deals with the spectral response of the original speech signal, while the Formant Synthesis technique follows the spectral peaks of the signal. Linear Predictive Coding technique first implemented by Texas Instruments in speech ICs actually attempts to simulate the human vocal tract, as you will see later.

The easiest parameter encoding technique to understand is the Channel Vocoder. In this system, the speech signal is fed to a signal analyzer, which consists of a bank of bandpass filters. The filters are designed so that the signal can be subdivided into several narrow bands. After the signal has been divided, the energy in each band is detected and stored in memory. Reproduction of the speech signal is accomplished with a synthesizer that consists of a bank of narrow-band frequency generators, whose outputs correspond to the same frequency ranges as the analyzer's filters. The signal generators are oscillators that are controlled by pitch and amplitude in-

for- mation extracted from the original speech signal. Figure 2 shows a block diagram of a Channel Vocoder's analyzer and synthesizer.

Comparing this with the other methods, the data rate of the Channel Vocoder is on the order of 2,400 bits per second.

A second parameter encoding technique is called Formant Synthesis. In Figure 3, which is a frequency spectrum of a short segment of a voiced sound, two important characteristics can be pointed out: The overall decreasing amplitude with respect to frequency, and the peaks in the envelope (called "formants").

Formant synthesis reproduces speech by recreating the spectral shape of the waveform. It does this by using the formant center frequencies, their bandwidths, and the pitch period as the inputs. The data rate for formant synthesis is typically on the order of 500 bits per second.

The last parameter encoding technique to be discussed is Linear Predictive Coding. LPC can best be described as a mathematical model of the human vocal tract. Referring to Figure 4, note that the parameters used to control the model represent the amount of energy delivered by the lungs (amplitude), the vibration of the vocal cords (pitch period and the voiced/unvoiced decision), and the shape of the vocal tract (reflection coefficients). The particular model used in TI's TMS-5100 and 5200 voice synthesis chips is called the LPC-10. The numeral ten indicates that the model utilizes ten reflection co-efficients, or "poles" to model the vocal tract. The data rate for the LPC-10 varies typically between 1,200 and 2,400 bits per second.

In each of the parameter encoding techniques described, the output speech waveform does not necessarily resemble the original speech signal introduced to the input analyzer, but then again, the purpose here is to duplicate the spectral shape of the speech signal or to duplicate the human vocal tract, and not necessarily the exact speech input waveform as in the waveform encoding techniques.

Putting it together

Once a given speech synthesis technique has been selected, one must next settle on a choice for the method of speech construction. Speech information can be stored in memory in three basic formats.

First, complete phrases can be stored to be played back through the synthesizer whenever needed. Using this method, the naturalness and "prosody" (meaning a combination of pitch, duration and intensity) of the speech are preserved. However, the storage cost and flexibility of the system will present significant difficulties. For example, every phrase the system will ever be required to speak must be stored in memory, and these phrases *cannot* be rearranged into new ones.

A second construction technique, which increases the flexibility of the speech system, is *word concatenation*. In this system, individual words are stored in memory and can be connected together to form phrases. Flexibility resides in the fact that each word is stored only once, but can be used repeatedly to create many different phrases. Its speech quality, however, is inferior to that of the phrase construction technique because when the individual words are called from memory and strung together, they have an unnatural and artificial quality.

The maximum amount of flexibility is achieved when words are broken down into their component sounds. These types of components are known as phonemes, allophones, diphones, demisyllables, morphs, or a combination of all or some of these different types can be used. With these units to build with, virtually any word or phrase can be created. While the memory requirement is reduced to only that which is necessary to store all the sound components, the quality of the generated speech, even more so than the two previously described construction methods, is highly unnatural and artificial.

Therefore, the three major limiting factors which need to be dealt with in designing a speech synthesis system are: flexibility, memory cost, and speech quality (naturalness and intelligibility). The more flexible the construction technique, the less the memory costs, and the less natural the speech sounds. Increased speech quality demands more memory and gives less flexibility. Therefore, when communication is the primary goal of the speech system, construction from component sounds is the optimal solution. But, when speech naturalness is the goal, phrase construction is the choice.

In order to obtain maximum flexibility to create an unlimited vocabulary while maintaining a minimum amount of memory requirement, a library of component sounds is required. With these component sounds, any word or phrase can be constructed. Figure 5 shows a typical text-to-speech system configuration. An English or phonetic text is translated by the pre-stored speech formation rules, and analyzed by a syntax analyzer for the prosodic characteristics of the text. Component sounds are then drawn from the library. The speech construction program operates on these sounds according to the prosody, before transmitting them to the speech synthesizer. The system usually generates speech at a typewriter rate of 75 bits per second.

Note that the system described herein contains a speech synthesis technique and also a speech construction technique. The synthesis device used in Figure 5 may be any one of the synthesis techniques described earlier. The

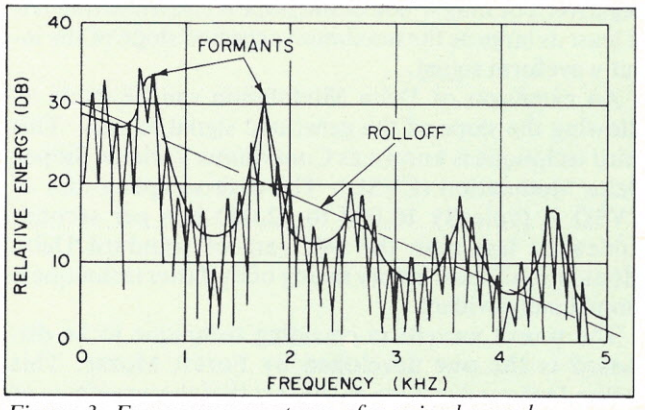

Figure 3. Frequency spectrum of a voiced sound.

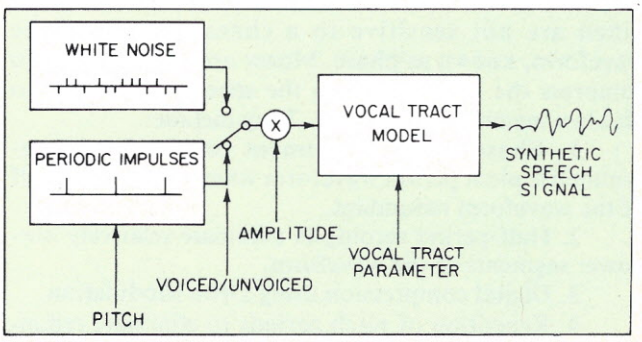

Figure 4. Mathematical model of vocal tract.

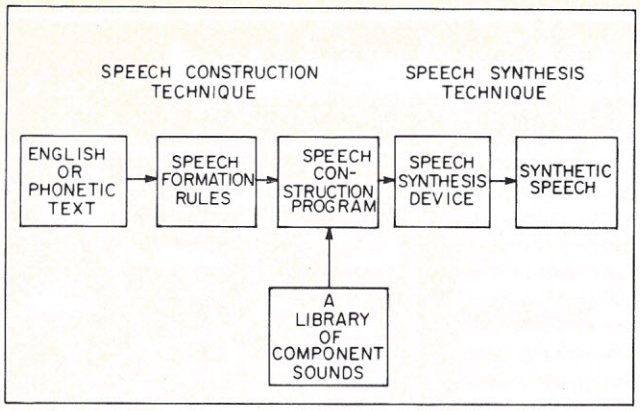

Figure 5. A block diagram of a typical text-to-speech system configuration.

user should be aware of the independence between synthesis and construction techniques. Furthermore, the library of component sounds may consist of phonemes, allophones, diphones, demisyllables, morphs, or even a combination of the above sounds.

Construction Alternatives

Different types of component sounds in speech construction have different trade-offs in the major criteria: program flexibility, memory cost, and speech quality. Every text-to-speech system attempts to preserve the speech intelligibility at the sacrifice of naturalness to varying degrees.

Phonemes

The simplest and the most flexible building blocks in speech construction are phonemes. As mentioned earlier, the English language has 16 vowels and 24 consonants, making a total of 40 phonemes. Theroretically, if one has a library of these phonemes, it should be possible to construct any work or phrase desired.

However, when each phoneme is actually pronounced in human speechthere are many minor variations which occur between sounds. The inherent inaccuracies is machine phoneme pronunciation can occasionally create difficulty in understanding speech generated with this technique. A commercially available voice synthesizer that uses phonemes is the Votrax VS-6 synthesizer. It has a library of 40 phonemes, 22 of which are duplicated with different lengths, and 2 pauses. Each of these 64 sounds may assume one of four pitch levels.

Diphones

A diphone is defined as the sound that extends from the middle of one phoneme to the middle of the next phoneme. It is chosen as a component sound for the smoothing required between adjacent phonemes. However, in order to encompass many of the coarticulation effects in English, a large inventory of diphones is usually required. The diphone synthesis system developed by Bolt Beranek & Newman, Inc. of Cambridge, MA requires an inventory of approximately 2,650 diphones, which require a storage space of 236K bytes, and a powerful CPU to handle the construction program. Obviously, this approach would not be feasible for general consumer applications.

Demisyllables

A syllable in any language may be divided into an initial demisyllable, a final demisyllable, and possible additional phonetic affixes. The initial demisyllable consists of any initial consonants and the transition into the vowel sound. The final demisyllable consists of the vowel and any core-final consonants. The phonetic affixes consist of all syllable-final non-core consonants.

Morphs

The smallest unit of sound that has a meaning (i.e. root words, phonetic affixes, and suffixes) is known as a morph. According to J. Allen, the designer of MITALK, synthesizing speech from unrestricted English text requires a dictionary of 12,000 morphs. The memory requirement is 600K bytes. While the speech generated by MITALK is intelligible and quite natural, the system cost to the general consumer is, again, prohibitively expensive.

Allphones

An allophone is a subset of a phoneme, which is modified by the environment in which it occurs. For example, the aspirated /p/ in "push," and the unaspirated /p/ in "Spain," are different allophones of the phoneme /p/. Thus, allophones are more accurate in representing sounds than are phonemes. The Texas Instruments text-to-speech system, which has recently been developed, has a library of 128 allophones stored in 3K bytes of memory. Thus, the memory cost of this system is considerably less than those previously described.

To translate regular English text into the allophonic version of a phoneme, a set of 650 rules was developed. These rules are stored as a "look-up" table in another 7K bytes of memory. A speech construction algorithm is then used to string allophones, smooth parameters, adjust prosody, and produce natural speech. This algorithm, fortunately, is simple enough to be implemented by a microprocessor. The accuracy of component sounds, small memory requirement, and simplicity of construction algorithm have made this text-to-speech system very affordable by general consumers.

Summing Up

So far, we have presented the background on speech synthesis, including various synthesis models, speech construction techniques, human speech generation, and present technologies for test-to-speech.

Different speech construction approaches in text-to-speech such as phonemes, diphones, demisyllables, morphs, and allophones, and the trade-offs between program flexibility, memory cost, and speech quality were also discussed.

(In May: Microcomputer speech systhesis.) □

Editor's Note: The editors of Personal Computing *would like to know of any original or newly-developed applications in the area of computer-generated speech technology; either in hardware or software. This applies both to our readers and to manufacturers. We would also be interested in your opinions on articles of this nature; whether or not you would like to see more of them in future issues of* Personal Computing.

How human speech is generated

The following section dealing with the mechanics of speech generation in human beings will help to explain the choices made regarding the component units of sounds used to produce unlimited vocabulary systems.

The Vocal Tract

Human speech is produced in the vocal tract, using organs which are used primarily for breathing and eating, and only secondarily for speech. The tract consists of the lungs, the trachea and "voice box," the oral cavity and the nasal cavity. The oral cavity extends from the back of the throat (the pharyngeal wall) to the lips. The lips, teeth, tongue, and soft palate (or "velum"), are of primary importance in forming speech sounds. The soft palate also functions as a divider between the oral and nasal cavities. It is, in fact, a muscle which may be raised against the pharyngeal wall, or pulled away from it (like a door), thereby either blocking the airstream from flowing through the nasal passages, or allowing it to do so.

The lungs act primarily as a bellows, setting the air in motion through the vocal tract. In its passage through the trachea, the air passes through the "voice box" (or larynx) which contains the vocal cords. These cords are actually thin bands of muscle which can be stretched across the airstream or allowed to relax at the sides of the airflow. When these bands are stretched across the airflow with the correct amount of tension, they vibrate in the manner of a windowshade buzzing in the wind, or the reed of a woodwind instrument such as a clarinet. Figure 6 depicts the vocal tract, outlining the locations of the oral and nasal cavities and their various components.

Three components

There are three necessary components for audible human speech: First, an airstream is required to set the air in motion through the vocal tract. Second, articulation must occur to modify the airstream as it flows. Third, a phonation process at the larynx may further modify the airstream as it passes the vocal cords, adding a periodic buzz called "voice." These processes often occur simultaneously in the production of any one sound, but for purposes of clarity in this discussion, they will be treated as separate functions here.

As already mentioned, the airflow is usually set in motion by the bellows action of the lungs, the primary airstream mechanism. Most often, speech is generated by the exhalation of air from the lungs. It is also possible to generate speech sounds while inhaling. Two secondary methods of setting the air in motion in the vocal tract are by moving the larynx up and down while the vocal cords are closed, and also by using the tongue to suck air into the mouth as when clucking encouragingly to an animal.

Articulation is the term used to refer to what the organs of the vocal tract are doing to modify the shape and dynamics of the airstream. When describing articulation, it is necessary to determine two factors: which organs of the vocal tract are involved in shaping the airstream; the "place of articulation" and the "articulators," and secondly, what kind of modification of the airstream the organs (or "articulators") are causing, the "manner of articulation."

The active organs of the vocal tract used to modify the airstream are called the "articulators." These consist of the lower lip, the tongue-tip, the tongue-blade, and the tongue-back. Occasionally, the vocal cords are used as an articulator, as when producing a sound known as a "glottal stop." (Say the word "bottle" as if you were pronouncing the sounds "bah-ul." The sound replacing the "T" is a glottal stop.)

The passive organs of the vocal tract are known as "places of articulation." The articulators either approach or retreat from the places of articulation to effect varying degrees of constriction in the production of different sounds. The various places of articulation include: the upper lip, the upper teeth (the incisors), the alveolar ridge (the bony ridge of gums just inside the front teeth), the front of the palate behind the alveolar ridge, the center of the palate (the hard palate), the soft palate (or velum), and the very end of the soft palate which hangs free in the back of the mouth, known as the uvula. The pharynx and vocal cords may also be considered places or articulation.

Manners of Articulation

The movements of the articulators, with regard to their position relative to the places of articulation, may be classified in terms of their effect upon the flow of air through the vocal tract.

The *stop* manner of articulation occurs when the constriction of the passageway is complete; when no air flows between the articulator and the place of articulation. Examples of "stops" are: /p/, /b/, /t/, /d/, /k/, and /g/, where the slash marks represent the phonetic alphabet operator.

The *fricative* manner of articulation occurs when the articulator causes a partial obstruction to the flow of air in the vocal tract, so that air flow past the point of articulation is turbulent. Examples of "fricatives" are: /f/, /v/, /U/ (as in the word "thin"), /ð/ as in the word "then"), /s/, /z/, /š/, /ž/, and /h/.

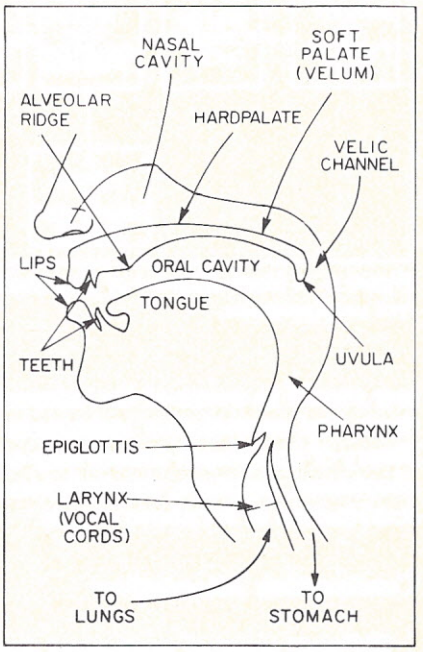

Figure 6. A representation of the human vocal tract depicting the locations of the oral and nasal cavities and their respective components.

An *affricate* is a sound which begins with a stop and is released into a fricative at the same point of articulation. Examples of affricates in English are: /ts/ (as the first and last sounds in the word "church"), and /dz/ (as in the first and last sounds in the word "judge").

Sonorants, or *approximants* are sounds generated during a condition of partially obstructed airflow, but do not exhibit turbulence at the point of articulation. In English, sonorants are divided into several categories. Two of these categories are based on the direction of the airflow in the vocal tract. Most speech sounds in the mouth are produced with the airstream flowing over the center of the tongue toward the front teeth. The approximant /1/, however, is released over the sides of the tongue, more toward the molars. Thus the /1/ is called a *lateral*, or a *laterally released sonorant*.

The other category of sonorant named for the direction of airflow is that of the *nasals*, or *nasal stops*. For most sounds the velum is raised against the pharyngeal wall, closing off the velic channel, and forcing the airstream to flow only through the oral cavity. In *nasals*, the velic chanel is left open, In *nasals*, the velic channel is left open, and the air is allowed to flow through the nasal cavity as well as, or instead of, through the mouth (unless, of course, you happen to have a really bad

head cold!), Examples of *nasals* are: /m/, /n/, and the nasal sound in the word "sing."

Another variety of sonorant, called *glides*, or *semivowels*, involves a nonturbulent obstruction of the airflow at the point of articulation, after which the articulator quickly moves on to meet the next sound. These sounds are characterized by their momentary nature. Examples of these sounds in English are: /w/ and /y/.

Phonation

Phonation refers to what is happening at the vocal cords while the airflow and articulation are occurring. The simplest way to describe phonation conditions is to say that a sound is either "voiced," or "unvoiced" in its production. A voiced sound is produced when the vocal cords are stretched across the airstream (without shutting it off completely), and a periodic buzz is superimposed on the airstream.

On the other hand, for an unvoiced sound, the vocal cords are relaxed and open, and the airstream flows through the larynx with only slight obstruction, resulting in silent breathing or an /h/ sound (depending upon the energy level of the airstream).

Some examples of voiced sounds are the vowels and sonorants previously mentioned. Some examples of unvoiced sounds are /p/, /t/, /k/, /f/, /s/, and /h/.

Figure 7 illustrates the vocal tract configurations and places of articulation for some common English speech sounds.

The vocal tract can be thought of as a

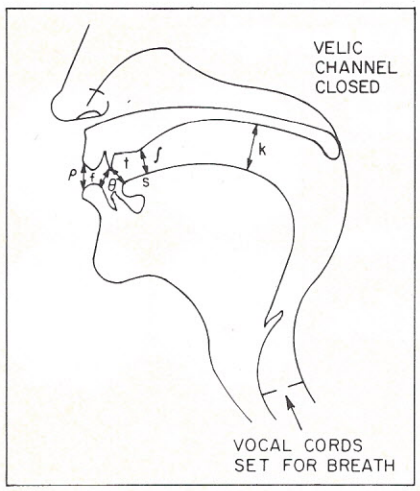

Figure 7. Vocal tract configurations and places of articulation for some speech sounds.

series of resonating chambers which change in shape due to the motion of the articulators. The changing shapes of the vocal tract give different sound qualities to the different speech sounds

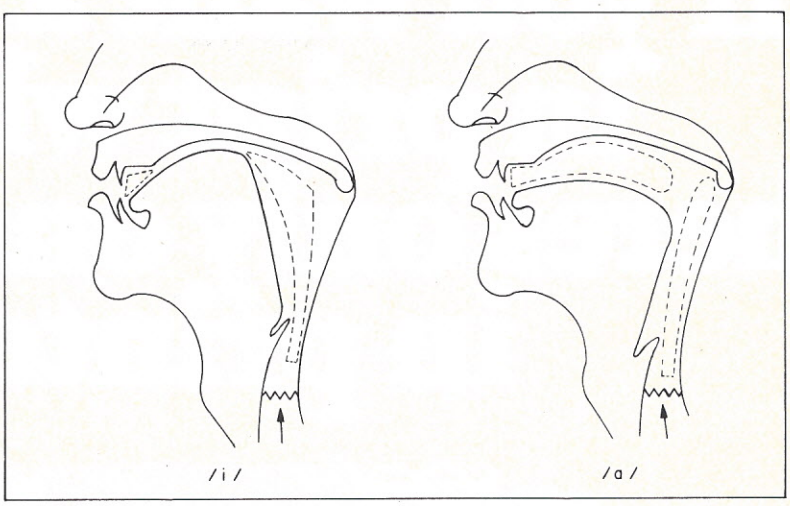

Figure 8a. The vocal tract configuration for the vowel /i/. Figure 8b (right). The vocal tract configuration for the vowel /a/.

/i/	BEET	/ɨ/	RABBIT	/u/	BOOT
/I/	BIT	/ɛ/	BIRD	/U/	BOOK
/ei/	BAIT	(/ə/	BUTTER)		
/ɛ/	BET	/ʌ/	BUT	/ow/	BOAT
/s/	BAT	(/ə/	ABOVE)	/ɔ/	BOUGHT
		/ɑ/	BODY		
/ɑi/	BITE				
/ɑu/	BOUT				
/oi/	BOY				

Table 3. A listing of the vowel sounds generally used in English. Some pronounciations will vary with dialect.

produced similar to the manner in which a tuba possesses a different sound quality than a trumpet. The shapes of the vocal tract chambers either emphasize or de-emphasize certain of the harmonic overtones of the voiced airstream, and also modify the character of the unvoiced airstream.

For example, in the word "eat," the tongue is positioned both high and towards the front of the mouth, producing a relatively small chamber in front of it, and a larger-sized chamber behind it. The larger chamber has a tendency to resonate at frequencies of 12,000 Hz or below, and the smaller one has the capability of affecting harmonic frequencies anywhere in the range of 500 to 5,000 Hz. In other words, the size of the chambers produced by the position of the articulators has much to do with the amplification or attenuation of certain sounds by harmonic resonance. Anyone who has ever experimented with the construction of an unbalanced dipole antenna for radio transmission will understand the significance of this mechanism. Figure 8a diagrams the vocal tract configuration for the vowel /i/ (as in "eat"), while Figure 8b depicts the configuration for the vowel sound /a/ (as in the word "hot").

So far, the characteristics of speech sounds have been discussed only in general terms. However, when each sound is actually pronounced, there are literally hundreds of minor variations which may occur to create the differentiation between sounds that would otherwise be classed as being the same.

According to the language being used, some of these will be perceived as making a difference between two sounds, and some will not. In English, for instance, the feature of voicing is considered significant, differentiating between sounds like /f/ and /v/. However, the feature of aspiration (adding a puff of breath after voiceless stops) is not significant, thus failing to differentiate between the /p/ in "spin" and the /p/ in "pin."

The sounds which are perceived to be the same in any one language, ignoring the minor differences between them, are the *phonemes* of that language. In addition to the consonant phonemes, there are about 16 vowel phonemes, making a total of about 40 phonemes in English. It should be noted that these are, after all, abstractions, since each classification of a particular speech sound as a particular phoneme ignores certain features of the sounds.

The vowel sounds of the English language are represented by the list of words in Table 3. Obviously, some pronunciations will vary with different dialects of English. □

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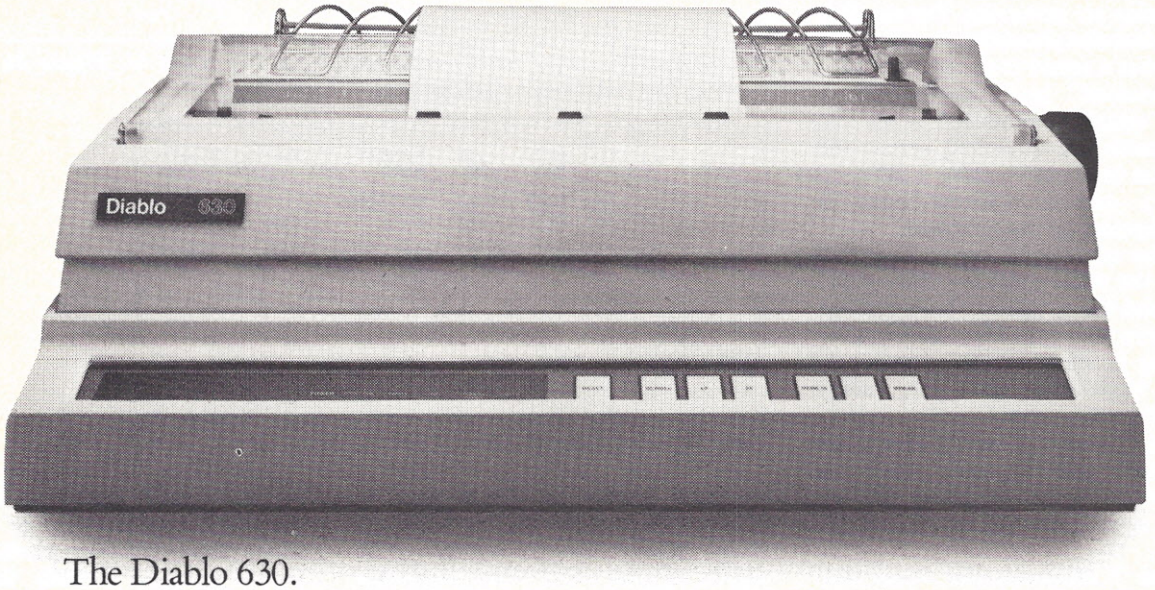

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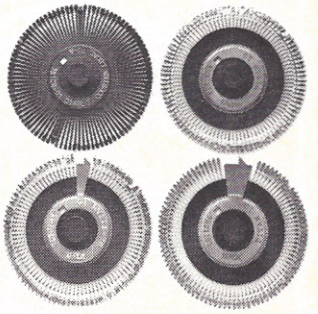

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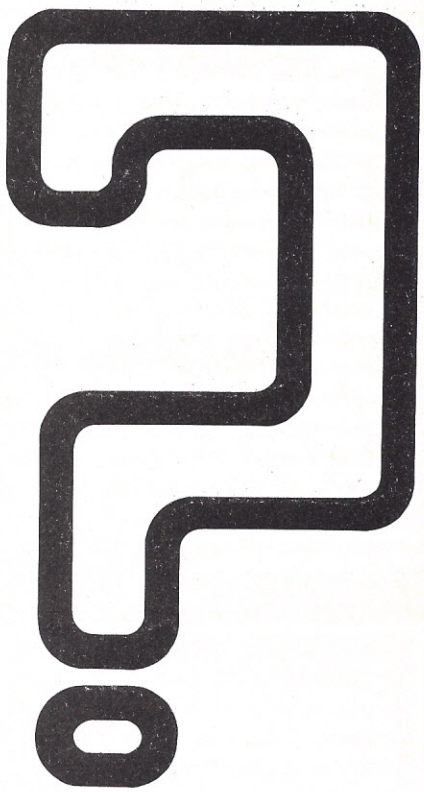
CIRCLE 25

Should Probability Be Added To Your Simulation



BY CHARLES J. WILSON

Last month, I introduced the basic concepts involved in building a simulation and talked about uncertainty and how to handle it. At that time, I kicked around the terms *probability* and *probability distribution*. This month, I'm going to expand on those terms and show how they are used in computer simulations.

Probability Theory

Probability theory is concerned with situations that are uncertain. Uncertainity arises when any one of a number of different outcomes can occur in a particular situation. For example, the weekly demand for a certain brand of beer from a distributor may be random, or the time between arrivals of customers at a bank's drive-in window may be random. As you might expect, probability theory is a deep mathematical subject requiring many college semesters for complete coverage. This means that I can only hit the fundamentals and, if I spark your interest, you can dig deeper using the books listed at the end of this article.

In probability theory, each outcome is assigned a measure that describes the likelihood that it will occur. This measure is called the probability of the outcome. The measure is constructed such that it is never less than zero and never more than one. A probability of zero means that an outcome will never occur. A probability of one means that the outcome will always occur—the outcome is certain. The probabilities of all possible outcomes for a particular situation must add up to one.

If I flip a coin into the air, the probability of it landing heads up is one-half and the probability of it landing tails up is one-half. The probability of either a head or a tail coming up—the only two things that can happen since I won't allow the coin to stand on edge—is one; the sum of the probabilities of the two possible outcomes. If I roll a fair die, the probability of a one is one-sixth, a two is one-sixth, and so forth.

Distributions and Functions

A table that lists all of the possible outcomes with their associated probabilities is called a probability distribution. The probability distribution for the fair die is below:

Outcome	1	2	3	4	5	6
Probability	1/6	1/6	1/6	1/6	1/6	1/6

Table 1. Probability distribution data for outcome of a fair die roll.

The probability distribution can be converted to a formula or function and this formula is known as a probability function. The probability function is usually represented as f(x). The probability function for the fair die is:

f(Outcome) = Probability of the Outcome = 1/6

for Outcomes = 1, 2, 3, 4, 5, and 6

The probability function associated with the fair die is a very simple one. In most cases, the function will be a good deal more complex. For example, if a coin is flipped n times, the probability of getting x heads is:

f(x) = Probability of x heads =

$$\frac{n!}{x!\,(n-x)!}\,p^{x}(1-p)^{n-x}$$

where p = the probability of a head on a single flip (p will be ½ for a fair coin).

This is mathematical shorthand for

n! = "n factorial."

n*(n-1)* (n-2) . . . (2)*(1).

This particular probability function is the binomial function and it is used where the outcome is binary (success or failure, heads or tails, on or off, etc).

Probability functions may be

either discrete or continuous, depending on whether the random variable (the outcome) described by the function can take on only certain values or all values in the interval being examined. The probability function describing the demand for beer would be discrete, since the distributor won't sell fractions of a can. However, the function of monthly water usage at the brewery would be continuous, since water flow can be divided into infintesimally small portions.

There is another function useful in the study of probability. It is called the cumulative distribution function. This function gives the probability that the random variable is less than or equal to some number, such as X. For the die example, a table containing the values of the cumulative distribution function would look like Table 2:

From the table you can see that the probability is 1/3(2/6) that a one or a two will turn up when the die is tossed. The probability is one (6/6) that a six or less will turn up; it is certain that one of the six possible faces of the die will show.

As you will find out later, the cumulative distribution function is one of the important ingredients of a simulation. In equation form, the cumulative distribution function is represented as F(x).

Determining Probabilities

While the probabilities associated with the tossing of a fair coin or the rolling of a fair die are easily computed, the probability of the occurrence of a certain outcome in most uncertain situations is more difficult to determine. You could observe the situation over a period of time and compute the probability of the outcome by finding the fraction of time it occurred while you were watching. On the other hand, you could use knowledge of the situation and assign a probability to the outcome based on your own best judgement. In many cases, sufficient data simply will not be available and assigning probabilities subjectively will be your only recourse. In addition, the situation may have changed to the extent that it would be dangerous to forecast the future based on the past—the historical probabilites may no longer apply.

X	1	2	3	4	5	6
Cumulative Distribution Function (Probability that number rolled is less than or equal to X)	1/6	2/6	3/6	4/6	5/6	6/6

Table 2. Cumulative distribution function for Olde Foamie beer.

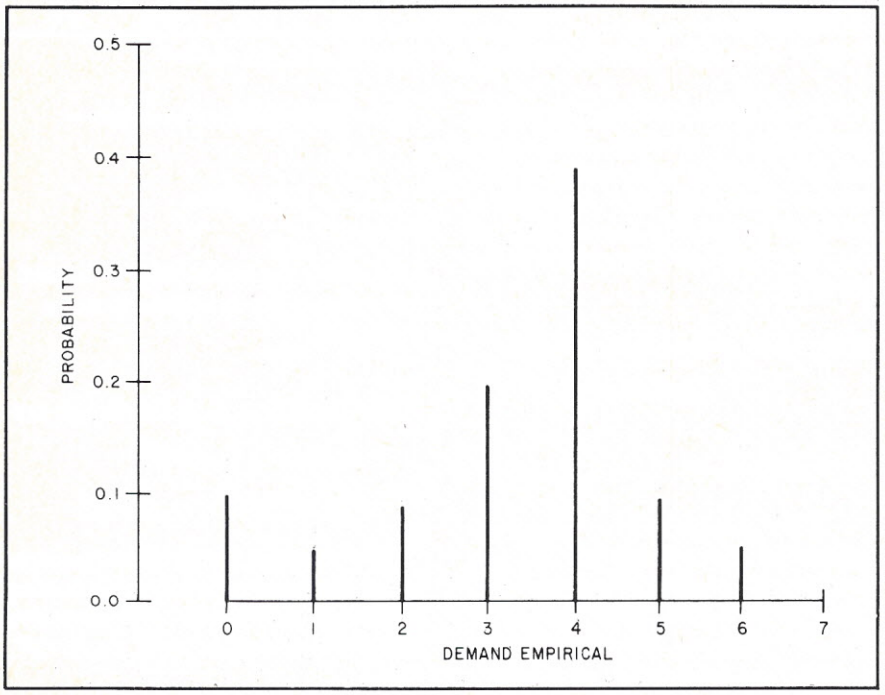


Figure 1. Probability distribution for demand from Table 3.

Distribution Parameters

Probability distributions are described by parameters that tell us what values to expect and how bunched up or spread out these values will be. The first parameter is the *mean*. The mean is the average value that the variable takes on. For example, if the demand for Olde Foamie beer for the past four days has been 2, 7, 1, and 6 cases, the mean demand has been (2 + 7 + 1 + 6)/4 or 4 cases per day—the total demand is divided by the number of observations. If the underlying conditions remain unchanged—the demand is not trending up or down, advertising is not changed, a heat wave does not occur—the mean of 4 cases is what the distributor could expect to sell tomorrow. The mean is therefore sometimes called the expected value.

One parameter that measures the spread of the distribution is called the variance. It is the average of the square of the deviations from the mean. For the Olde Foamie numbers, the variance would be

$$\text{Variance} = \frac{(2-4)^2 + (7-4)^2 + (1-4)^2 + (6-4)^2}{4}$$

$$= 26/4 = 6\tfrac{1}{2}$$

Sometimes, the square root of the variance is used to measure the variations from the mean. This measure is called the standard deviation.

$$\text{Standard Deviation} = \sqrt{\text{Variance}} = \sqrt{6.5} = 2.25 \text{ cases}$$

The mean and standard deviation are the only two distribution parameters that I'm going to address in this introductory article. For the applicability and computation of other parameters you may be familiar with (median, mode, range, skewness, etc.), I refer you to any one of the probability references given in the bibliography.

Non-Uniform Random Numbers

Once you know the cumulative probability distribution for a situation, you can use the uniform random number generator that came with your computer to produce a random variable from the distribution.

Daily Demand (cases)	0	1	2	3	4	5	6	7
Probability	.10	.05	.09	.20	.40	.10	.05	.01

Table 3. Data for probability distribution for demand.

Daily Demand (cases)	0	1	2	3	4	5	6	7
Cumulative Probability	.10	.15	.24	.44	.84	.94	.99	1.00

Table 4. Cumulative distribution for demand.

```
100 REM  NON-UNIFORM RANDOM NUMBER GENERATOR
110 REM  CUMULATIVE PROBABILITIES IN ARRAY A
120 REM  OUTCOMES IN ARRAY B
130 REM  RND(?) PRODUCES A UNIFORM R.N. BETWEEN 0 AND 1
140 LET  X=RND(?)
150 FOR  J=1 TO N
160 IF   X > A (J) THEN 190
170 LET  D=B(J)
180 RETURN
190 NEXT J
200 REM  D IS NON-UNIFORM RANDOM VARIABLE
```

Table 5. Subroutine for generating non-uniform random numbers.

How do you do this? Let's look at an example. Suppose you have observed the daily demand for Olde Foamie beer over a period of several months and found the probability distribution for demand to look like Table 3. In graph form, this distribution would appear as Figure 1.

The cumulative distribution for Olde Foamie appears in Table 4. and its graph would be as shown in Figure 2.

You can now use this cumulative distribution to generate daily demand for your simulation. First, you select a uniform random number between 0.0 and 1.0. Suppose the number selected is 0.53. Draw a horizontal line from 0.53 on the cumulative probability axis and continue it to the right until it hits a vertical line from the graph. (See the dotted line on Figure 2.) Drop straight down and read the value on the horizontal axis and you have your random demand value; in this instance, four cases. Similarly, a uniform random number of 0.91 would produce a demand of five cases and one of 0.12 a demand of one case.

Of course, your computer probably does not have the capability of drawing lines on graphs to generate random variables. (Perhaps I'm being presumptuous. I know mine doesn't. I really don't know what special features you may have.) Instead you must store in memory an array of cumulative probability values and compare the uniform number generated by your computer to the array values.

In the discussion that follows, I have attempted to avoid confusion regarding the uniform random number generators embodied in the various BASIC interpreters. In some BASICs, RND (0) produces a uniform random number between 0 and 1. In other BASICs, RND (1) performs the same function. No doubt there are other interpreters that use different notations. Therefore, I am going to use RND (?) to represent the built-in uniform random number generator. When you incorporate any of the following routines in your programs, you must remember to replace the "?" with "0", "1", or what ever your interpreter uses.

Let's look at an example. You have your **N**-cumulative probailities in array **A** from A(1) to A(N) and the **N**-associated demand values in array **B** from B(1) to B(N). Your computer's uniform random number generator returns a value of X. If you have the subroutine seen here in Table 5, the daily demand value can be found easily.

I programmed this routine on my computer and put the Olde Foamie data in the arrays. **A** contains the values 0.10, 0.15, 0.24, 0.44, 0.84, 0.94, 0.99, and 1.00 while **B** contains 0, 1, 2, 3, 4, 5, 6, and 7. The first ten weekly demands simulated by the routine were: 4, 4, 0, 0, 6, 4, 4, 4, 0, 6.

The above procedure will work for any situation where you input a discrete cumulative probability distribution or where you approximate a continuous cumulative distribution in a discrete fashion.

If the probability function is known in equation form, you can generate non-uniform random variates using several techniques, depending on which distribution is being simulated. In the discussion that follows, I am going to address those distributions that you are most likely to encounter.

Binomial

The binomial distribution applies when the event of interest can

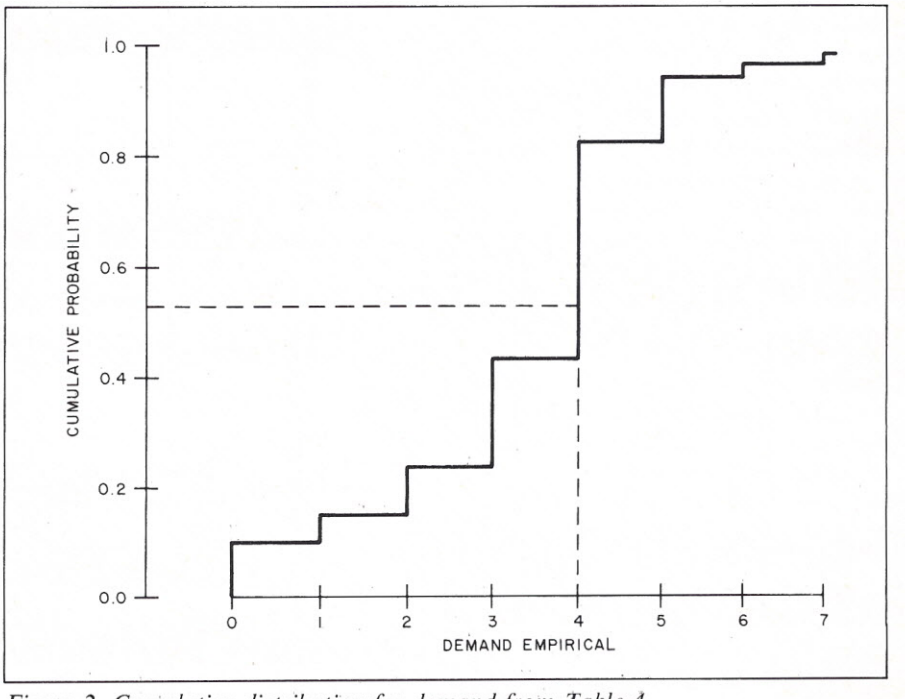


Figure 2. Cumulative distribution for demand from Table 4.

have only two outcomes—success or failure, yes or no—and the probability of a particular outcome remains constant over time. This distribution would be appropriate when modeling equipment failures or consumer sampling. The binomial is a discrete distribution, taking on only integer values. It is concerned with the probability of having x successes in n trials.

The probability distribution for the binomial is:

$$f(x) = \frac{n!}{x!\,(n-x)!}\,p^x\,(1-p)^{n-x}$$

$$x = 0, 1, 2, \ldots, n$$

where n = number of trials
x = number of successes
p = probability of success on each trial
! represents the mathematical factorial operation

Thus, f(x) is the probability of x successes in n trials.

The cumulative distribution function is:

$$\mathbf{F}(k) = \sum_{x=0}^{k} \frac{n!}{x!\,(n-x)!}\,p^x\,(1-p)^{n-x}$$

and represents the probability of k or less successes in n trials. Illustrations of the binomial probability distribution and cumulative distribution are shown in Figure 3.

If you want to generate a random variable from the binomial distribution, the subroutine of Table 6 can be used.

With N = 10 and P = 0.6, this routine produced the following ten binomially distributed random numbers when called ten times: 5, 6, 8, 6, 5, 6, 5, 6, 6, 7.

Geometric

The geometric distribution is a discrete distribution similar to the binomial except that it deals with the probability of the number of trials required to get the first success. The probability distribution function is:

$$f(x) = p(1-p)^{x-1} \quad x = 1, 2, 3, \ldots$$

where x = number of trials required
p = probability of success on a single trial

and the cumulative distribution function is:

$$\mathbf{F}(k) = \sum_{x=1}^{k} p(1-p)^{x-1}$$

Examples of these distributions are shown in Figure 4.

The subroutine seen in Table 7 will generate geometrically-distributed random variables:

This routine generated the following ten random variables on ten sample runs: 1, 1, 2, 2, 1, 2, 2, 1, 2, 7 when P was equal to 0.6.

Poisson

This discrete distribution is one of the most often used distributions in business simulations, since it is important in those cases where waiting lines form; a frequent problem. It can be used for determining the number of customers arriving at a store during a time period, the number of insurance claims in a month, the number of defects in a piece of material, or the number of phone calls per minute at a switchboard.

The probability distribution function for the Poisson looks like this:

$$f(x) = \frac{a^x e^{-a}}{x!} \qquad x = 0, 1, 2, \ldots$$

where a = mean rate (e.g., average arrivals per hour)
e = base of natural logarithms
x = number of occurrences
! represents the factorial

Its cumulative distribution function is:

$$\mathbf{F}(k) = \sum_{x=0}^{k} \frac{a^x e^{-a}}{x!}$$

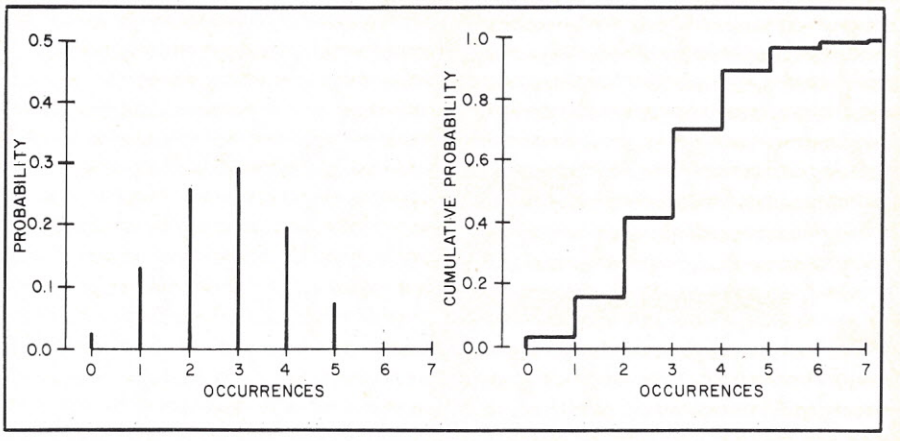


Figure 3. Binomial probability (left) and cumulative (right) distribution.

```
100 REM  GEOMETRIC RANDOM VARIATE GENERATOR
110 REM  P IS THE PROBABILITY OF SUCCESS ON A SINGLE TRIAL
120 REM  RND(?) PRODUCES A UNIFORM R.N. BETWEEN 0 AND 1
130 REM  LOG ( ) IS THE NATURAL LOGARITHM FUNCTION
140 LET  X%=LOG (RND(?)) /LOG(1-P)+1
150 REM  X% IS THE NUMBER OF TRIALS UNTIL FIRST SUCCESS
160 RETURN
```

Table 6. Subroutine for generating geometric random variates.

```
100 REM  BINOMIAL RANDOM VARIATE GENERATOR
110 REM  N IS THE NUMBER OF TRIALS
120 REM  P IS THE PROBABILITY OF SUCCESS ON A SINGLE TRIAL
130 REM  RND (?) PRODUCES A UNIFORM R.N. BETWEEN 0 AND 1
140 LET  X=0
150 FOR  I=1 TO N
160 IF   RND(?)>P THEN 180
170 LET  X=X+1
180 NEXT I
190 REM  X IS THE NUMBER OF SUCCESSES IN N TRIALS
200 RETURN
```

Table 7. Subroutine for generating binomial random variates.

An example of each of these functions is shown in Figure 5.

A subroutine for computing Poisson-distributed random variables is shown in Table 8.

A sample of ten Poisson random variables generated by this subroutine with an average of five is: 2, 3, 9, 6, 1, 6, 5, 6, 3, 3.

Exponential

The first continuous distribution to be considered is the negative exponential distribution. This distribution is often used when studing waiting line (queueing) problems. It describes the probability associated with the time between customer arrivals or the service time for a particular customer. It is also used extensively in reliability studies where it describes the distribution of time between failures of a machine. The probability function for this distribution is:

$$f(x) = \frac{1}{a} e^{-x/a}$$

where a = mean time between occurrences.

The cumulative distribution function is:

$$F(x) = 1 - e^{-x/a}$$

These two functions are illustrated in Figure 6.

If you are dealing with a continuous probability function that is known in equation form, you can use your uniform random number generator to produce a random variable by employing the inverse transformation technique. The negative exponential is a distribution with which this technique can be used. Since you want the random variable and not the cumulative probability, a little algebra has to be done.

$$X = -a \cdot \log (1-F(x))$$

where log is the natural logarithm.

Now you can use RND(?) to generate a uniform random number between 0 and 1 and put that number in the equation in place of F(x). The computed x will be a random variable from the negative exponential distribution with a mean of a. In BASIC, this appears in Table 9.

Since 1-RND(?) is uniformly distributed like RND(?), line 140 could also be written as: 140 LET X = -A*LOG(RND(?)) saving a subraction step.

Ten example negative exponential random variables generated when the mean was 0.2 are: 0.062, 0.020, 0.200, 0.385, 0.066, 0.274, 0.018, 0.518, 0.321, 0.033.

Gamma

Another useful continuous distribution that is related to the negative exponential is the gamma. The gamma distribution is concerned with the time required for a specified number of events to occur; the total service time for five customers, for example.

The gamma function in equation form is:

$$f(x) = \frac{x^{(k-1)} e^{-x/a}}{a^k (k-1)!}$$

An easily-used equation form cannot be found for the cumulative distribution. Thus, the inverse transformation technique can not be used. However, the subroutine in Table 10 will generate gamma random variables:

With a mean time between occurrences of 0.2 and 5 occurrences specified, the subroutine will generate random variables similar to the following list: 0.435, 1.542, 0.563, 0.881, 1.409, 1.147, 0.836, 0.853, 0.817, 2.048.

Normal

Another continuous probability distribution you will often encounter in simulating uncertain events is the

```
100 REM   POISSON RANDOM VARIATE GENERATOR
110 REM   A IS THE MEAN NUMBER OF OCCURRENCES IN INTERVAL
120 REM   EXP ( ) IS THE EXPONENTIATION FUNCTION
130 REM   RND(?) PRODUCES A UNIFORM R.N. BETWEEN 0 AND 1
140 LET   X=0
150 LET   EX=EXP(-A)
160 LET   PD=1.0
170 LET   PD=PD*RND(?)
180 IF    PD<EX THEN RETURN
190 LET   X=X+1
200 GOT   O 170
210 REM   X IS THE NUMBER OF OCCURRENCES
```

Table 8. Subroutine for generating Poisson random variates.

```
100 REM   NEGATIVE EXPONENTIAL RANDOM VARIABLE GENERATOR
110 REM   A IS THE MEAN TIME BETWEEN OCCURRENCES
120 REM   LOG( ) IS THE NATURAL LOGARITHM FUNCTION
130 REM   RND(?) PRODUCES UNIFORM R.N. BETWEEN 0 and 1
140 LET   X=-A* LOG(1-RND(?))
150 REM   X IS A RANDOM VARIABLE FROM NEGATIVE EXPONENTIAL
160 RETURN
```

Table 9. Subroutine for generating negative exponential random variables.

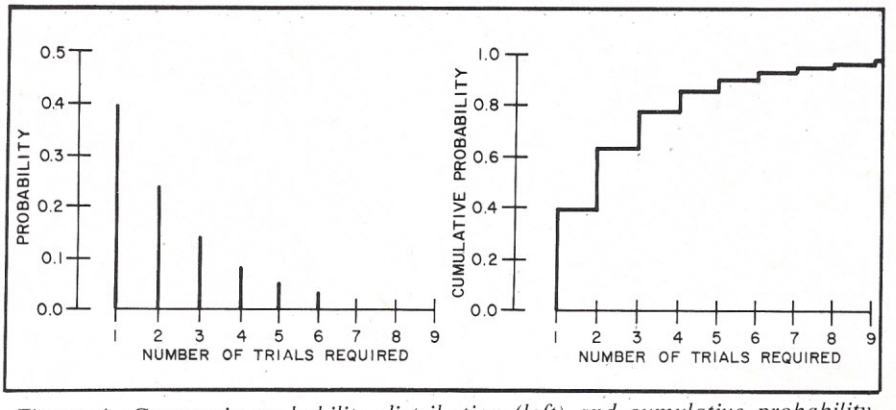


Figure 4. Geometric probability distribution (left) and cumulative probability distribution (right).

```
100 REM  GAMMA RANDOM VARIABLE GENERATOR
110 REM  A IS THE MEAN TIME BETWEEN OCCURRENCES
120 REM  K IS THE NUMBER OF OCCURRENCES SPECIFIED
130 REM  LOG ( ) IS THE NATURAL LOGARITHM FUNCTION
140 REM  RND(?) PRODUCES A UNIFORM R.N. BETWEEN 0 AND 1
150 LET  PD=1
160 FOR  I=1 TO K
170 LET  PD=PD*RND(?)
180 NEXT I
190 LET  X=-A*LOG (PD)
200 REM  X IS A GAMMA RANDOM VARIABLE
210 RETURN
```

Table 10. Subroutine for generating Gamma random variables.

```
100 REM  STANDARD NORMAL RANDOM NUMBER GENERATOR
110 REM  RND(?) PRODUCES A UNIFORM R.N. BETWEEN 0 AND 1
120 LET  S=0
130 FOR  I=1 TO 12
140 LET  S=S+RND(?)
150 NEXT I
160 LET  X=S-6
170 REM  X IS STANDARD NORMAL RANDOM VARIABLE
180 RETURN
```

Table 11. Subroutine for generating standard normal random numbers.

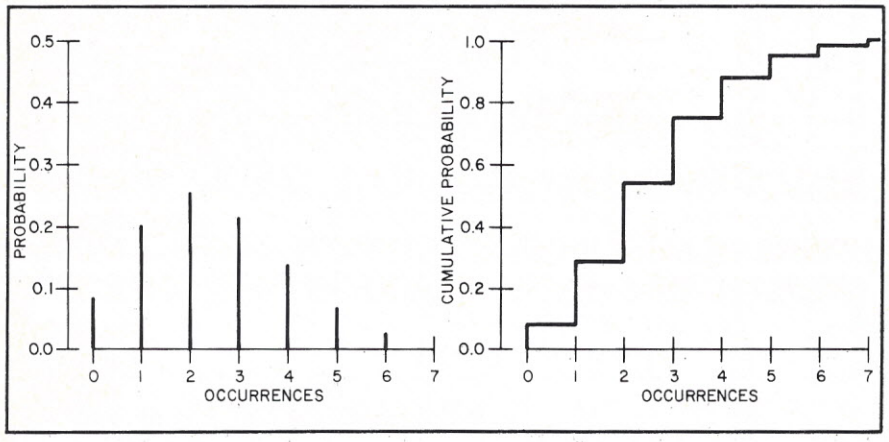


Figure 5. Poisson probability (left) and cumulative probability (right.)

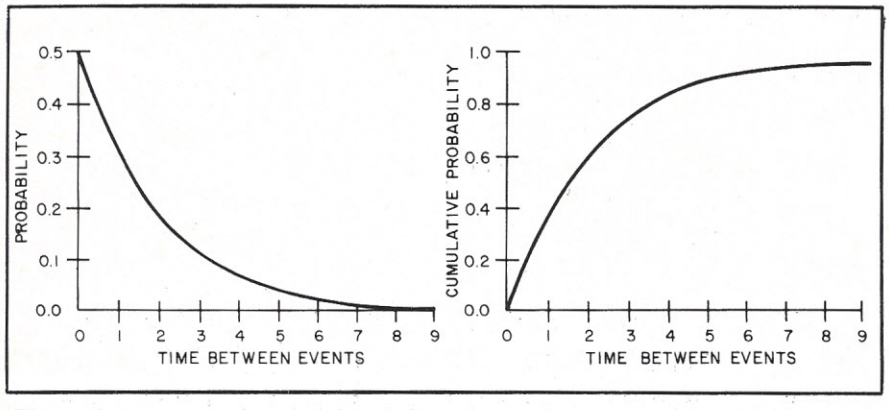


Figure 6. Exponential probability (left) and cumulative probability (right).

normal distribution. This is sometimes called the Gaussian distribution, and you may have heard it referred to as the "bell-shaped" curve. Many phenomena follow or can be approximated by the normal distribution, including: IQs, weights, component failures, and target localization errors.

The equation for the normal probability function is:

$$f(x) = \frac{1}{\sqrt{2\pi b}} = e^{-\frac{1}{2b^2}(x-a)^2}$$

where a = mean of distribution
b = standard deviation

The inverse transformation method cannot be used with the normal distribution. However, there are a number of ways that normal random variables can be generated. One method is to generate twelve uniform random numbers between 0 and 1, sum them, and subtract 6. This produces a normal random variable from a distribution with a mean of 0 and a standard deviation of 1. (This is sometimes called the standard normal distribution.) In equation form, this would be represented by:

$$X = \sum_{i=1}^{12} u_i - 6$$

where u_i is a uniform r.n. between 0 and 1

In BASIC, this would be programmed as seen in Table 11.

If the normal distribution of interest has a mean other than 0 and/or a standard deviation other than 1 (i.e., it is non-standard), the lines shown in Table 12 would have to be added to Table 11.

The first routine generated these ten standard normal variables: 1.799, -0.282, 0.451, 0.344, -1.697, -0.896, -0.291, -0.428, -1.040, 0.258, and the following ten non-standard (mean of 5 and standard deviation of 3) normal variables: 5.855, 0.822, 4.549, 2.019, 10.272, 4.331, 11.148, 8.537, 4.112, 9.228.

Another technique for generating normal random variables requires the generation of two uniform random numbers between 0 and 1 (let's call them u_1 and u_2) and substituting them in the following equations:

$X_1 = \sqrt{-2.\log(u_1).\cos(2 \quad u_2)}$

$X_2 = \sqrt{-2.\log(u_1).\sin(2 \quad u_2)}$

This method produces two normally distributed random variables from a distribution with a mean of 0 and a standard deviation of 1. Putting this second method in BASIC would give you the listing of Table 13.

Again, if your distribution does not have a mean of 0 and a standard deviation of 1, X1 and X2 will have to be adjusted accordingly.

Lognormal

The last distribution to be included in our discussion is the lognormal. This continuous distribution should be of interest to those of you simulating the price behavior of stocks. Many financial researchers believe that the logarithms of stock prices follow the lognormal distribution.

The probability distribution function for the lognormal is:

$$f(x) = \frac{1}{\sqrt{2 \quad bx}} \quad e \quad \frac{1}{-2b^2} \quad (\log x - a)^2$$

where a = mean of logarithm of variable

b = standard deviation of logarithm

A subroutine for lognormal random variables would incorporate one for the standard normal, as shown in Table 14.

Ten examples from this distribution when the mean logarithm is 3.4 and the standard deviation is 0.3 are: 35.91, 27.41, 38.46, 36.88, 22.92, 33.11, 13.63, 24.23, 25.94, 17.31.

Parting Comments

There are a large number of other distributions that might have been discussed. However, the seven I've included plus the empirical technique that was demonstrated should cover 99 percent of the cases you'll want to simulate.

In the concluding part of this series on simulation next month, we'll take a look at at actual application of a system simulation which was actually used to help one client make a business decision. Try to have all three parts of this article on hand to help with your simulation. □

```
180 REM  A=MEAN OF NON-STANDARD NORMAL DISTRIBUTION
190 REM  B=STD. DEV. OF NON-STANDARD NORMAL DISTRIBUTION
200 LET  Z=A+B*X
210 REM  Z IS NON-STANDARD NORMAL RANDOM VARIABLE
220 RETURN
```

Table 12. Add these lines to the subroutine of Table 11 for generation of non-standard normal distribution.

```
100 REM  STANDARD NORMAL RANDOM NUMBER GENERATOR
110 REM  LOG ( ) IS THE NATURAL LOGARITHM FUNCTION
120 REM  SQR ( ) IS THE SQUARE ROOT FUNCTION
130 REM  RND (?) PRODUCES A UNIFORM R.N. BETWEEN 0 AND 1
140 LET  PI=3.14159
150 LET  U1=RND (?)
160 LET  U2=RND(?)
170 LET  T1=SQR(-2*LOG(U1))
180 LET  T2-2*PI*U2
190 LET  X1=T1*COS(T2)
200 LET  X2=T1*SIN(T2)
210 REM  X1 AND X2 ARE STANDARD NORMAL RANDOM VARIABLES
220 RETURN
```

Table 13. Subroutine for generating two uniform standard normal random numbers.

```
100 REM  LOGNORMAL RANDOM VARIABLE GENERATOR
110 REM  A IS THE MEAN OF LOGARITHM OF VARIABLE
120 REM  B IS THE STD. DEV. OF LOGARITHM OF VARIABLE
130 REM  EXP ( ) IS THE EXPONENTIATION FUNCTION
140 REM  RND(?) PRODUCES A UNIFORM R.N. BETWEEN 0 AND 1
150 LET  S=0
160 FOR  I=1 TO 12
170 LET  S=S+RND(?)
180 NEXT I
190 LET  X=S-6
200 LET  Y=EXP (A+B*X)
210 REM  Y IS A LOGNORMAL RANDOM VARIABLE
```

Table 14. Subroutine for generating lognormal random variables.

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Subscription List

BY DAVID D. BUSCH

The average magazine subscriber is at a serious disadvantage. After all, the specialized companies that provide subscription bookkeeping services for the magazines all have computers to keep track of expiration dates, accounts receivable and so forth. Most consumers—*Personal Computing* readers excluded—have no access to such tools. Instead, they must spend a lot of time sorting through offers to subscribe to new magazines, bills for subscriptions that have been extended, and repeated exhortations from current magazines to sign up for ever-longer terms to beat impending price increases. If you're like me, you probably spend a lot of time trying to remember whether or not you already paid a subscription invoice, checked "Bill me," or decided to let a no-longer interesting publication lapse.

Subscription List is a disk-based program, written for the TRS-80 Model I, but adaptable to other BASICs. With the increasing popularity of specialty magazines, and the rising number of subscriptions paid for by the average household or business, it's easy to accumulate 10 or 15 different subscriptions. As a writer with a number of interests and hobbies, I subscribe to more that 40 publications, and pick up an equal number on the newsstand each month.

Why use a computer to keep track of magazine subscriptions? Any good checkbook balancing program will report whether or not a check has been issued payable to a certain magazine. Unfortunately a personal or business finance program of that type can't provide advance warning of when a subscription is due to run out. Because some magazines "cry wolf" and send four or five renewal notices months ahead of time, a busy reader is likely to ignore the notices until it is too late. Or, worse, reply to and pay for several renewals without realizing it.

In addition, many magazines today are owned by larger, parent corporations. If your accounts payable program has a check made out to Crain Communications, or Peterson Publishing Company, would you know, offhand, which magazine was involved?

Index cards are useful for persons with only few magazine subscriptions but for those of us with heftier reading lists—and who already use our computers to keep track of a number of personal data bases—the choice is easy. Which would you rather do, decide which stack of index cards to leaf through in order to locate some information, or slip a disk in a drive and let the computer do the work?

Subscription List stores the data temporarily in a two-dimensional string array, which consists of ROWS, one for each magazine, and three COLumns, for magazine title, expiration date and payment status. These data are output to a

Sample Run

```
                :: MENU ::

 1.) UPDATE SUBSCRIPTION STATUS
 2.) ENTER NEW SUBSCRIPTION
 3.) CANCEL OR NON-RENEW A SUBSCRIPTION
 4.) SAVE ENTRIES TO DISK
 5.) CHECK EXPIRATION STATUS
 6.) SEE ENTIRE FILE

   ENTER CHOICE :


ENTER MAGAZINE TITLE :? PERSONAL COMPUTING
ENTER RENEWAL DATE   (MM/YY) :? 06/81
HAVE YOU PAID FOR THIS SUBSCRIPTION? NO
ENTER AMOUNT DUE :? 14.00←


ENTER CURRENT MONTH-YEAR (MM/YY)? 06/81
 MAGAZINES THAT WILL EXPIRE WITHIN SIX MONTHS :

PERSONAL COMPUTING              06/81          14.00
READERS DIGEST                  07/81          Y

PRESS ANY KEY TO RETURN TO MENU
```

sequential disk file I've called MAGAZINE/FIL.

In running the program, six options are presented: updating the status of an existing subscription, entering a new subscription into the file, cancelling a subscription that has not been renewed, saving the current session's entries to disk, checking the expiration status of current subscriptions, and looking at the entire file in "pages" of ten entries.

The program breaks down neatly into several modules. SU, which is the maximum number of subscriptions expected to be in the file, is assigned the value of 40 in line 20. The variable SU is then used to DIMension the array MAG$(SU,3) in line 30. To enlarge the limits of the file, you just change the value of SU.

The next step in the program is to load existing data from disk. The first time you run the program, a FILE NOT FOUND error will occur, unless you first create the file. A simple way to do this is to type, in the command mode:

TT=1 (Enter)
GOTO 850

This step will create the file MAGAZINE/FIL, but will fill the file with nothing more than the value of TT. Then, when the program is run, the value of TT is loaded from the disk (line 50) and is used to set up a loop that loads any data in the disk file into the array MAG$(ROW,COL).

A straightforward menu is presented in lines 110-250; you are given six options. The INKEY$ routine accepts only numeric input from one to six and control is sent to one of six subroutines.

The first, at lines 260-540, allows updating information about a magazine already in the file. You input the name of a magazine, and the program searches through the first column of MAG$(ROW,COL) (line 290). The publication title must match exactly with that in the file, which keeps *Popular Mechanics* separate from *Popular Electronics*, but it means that you must input the correct spelling when creating and/or accessing the file.

If the title is located, current expiration date and payment status lists to the screen (lines 370-380) and you can change either or both pieces of information. Control then returns to the menu. Saving data to disk is *not* automatic. You *must* remember to save your entries before exiting the program.

New subscriptions are entered at lines 550-660. At the beginning of this routine, TT is incremented by one, and the data are added to MAG$(TT,COL). Thus, new data are automatically placed in a ROW, one position farther than the last entry.

Slightly trickier is the deletion option, found in lines 670-840. It's a simple matter to null the appropriate elements of the array to delete a subscription, but that would leave unneeded "holes" that take up memory. Instead, Subscription List takes the final entry in the array, and places it in the three columns vacated by the cancelled subscription. Then TT is decremented by one to take up the "slack."

To delete a subscription, you input the title, which, again, must match exactly with the title in the file (lines 680-700). If the magazine to be deleted happens to be the last one in the file (line 760), no attempt is made to shuffle around the elements of the array; the positions are simply nulled, and TT is reduced by one. In all other cases, the data from the last magazine in the array are moved into the positions occupied by the cancelled subscription (lines 770-790).

New and updated entries are saved in lines 850-920. The variable TT, which may have been increased or decreased during the RUN, is first printed to the disk,

Program Listing

```
5 '****** SUBSCRIPTION LIST ******
          DAVID BUSCH
          515 E. HIGHLAND AVE.
          RAVENNA, OHIO 44266

10 CLEAR 1000
20 SU=40
30 DIM MAG$(SU,3)
35 '****** LOAD CURRENT FILE INTO MEMORY ******

40 OPEN"I",1,"MAGAZINE/FIL"
50 INPUT #1,TT
60 FOR ROW=1 TO TT
70 FOR COL=1 TO 3
80 INPUT #1,MAG$(ROW,COL)
90 NEXT COL,ROW
100 CLOSE 1
105 '****** MENU ******

110 CLS:PRINT:PRINT
120 PRINT"                        :: MENU :: "
130 PRINT
140 PRINT"      1.) UPDATE SUBSCRIPTION STATUS"
150 PRINT"      2.) ENTER NEW SUBSCRIPTION"
160 PRINT"      3.) CANCEL OR NON-RENEW A SUBSCRIPTION"
170 PRINT"      4.) SAVE ENTRIES TO DISK"
180 PRINT"      5.) CHECK EXPIRATION STATUS"
190 PRINT"      6.) SEE ENTIRE FILE"
200 PRINT
210 PRINT "        ENTER CHOICE :"
220 A$=INKEY$:IF A$="" GOTO 220
230 A=VAL(A$)
240 IF A<0 OR A>6 GOTO 220
250 ON A GOTO 260,550,670,850,930,1080
255 '****** UPDATE EXISTING SUBSCRIPTION ******

260 CLS:PRINT:PRINT
270 INPUT"ENTER NAME OF MAGAZINE TO BE UPDATED :";N$
280 FOR U=1 TO TT
290 IF MAG$(U,1)=N$ GOTO 350
300 NEXT U
310 PRINT "NO MAGAZINE BY THAT TITLE FOUND."
320 PRINT "PRESS ANY KEY TO RETURN TO MENU"
330 IF INKEY$="" GOTO 330
340 GOTO 110
350 CLS:PRINT:PRINT
360 PRINT "  DO YOU WANT TO CHANGE :"
370 PRINT "       1.) EXPIRATION DATE   :";MAG$(U,2)
380 PRINT "       2.) PAYMENT STATUS    :";MAG$(U,3)
390 PRINT "       3.) BOTH"
400 PRINT
410 PRINT "     ENTER CHOICE :"
420 A$=INKEY$:IF A$="" GOTO 420
430 B=VAL(A$)
```

(Continued)

(Program Listing continued)

```
440 IF B<0 OR B>3 GOTO 420
450 ON B GOTO 460,480,460
460 INPUT" ENTER NEW EXPIRATION DATE  (MM/YY) :";UP$
470 MAG$(U,2)=UP$
480 INPUT"HAVE YOU PAID THIS SUBSCRIPTION";AN$
490 IF LEFT$(AN$,1)="N" GOTO 520
500 UP$="Y"
510 GOTO 530
520 INPUT"ENTER AMOUNT TO BE PAID :";UP$
530 MAG$(U,3)=UP$
540 GOTO 110
545 '****** ENTER NEW SUBSCRIPTION TO FILE ******

550 CLS:PRINT:PRINT
560 TT=TT+1
570 INPUT"ENTER MAGAZINE TITLE :";MAG$(TT,1)
580 INPUT"ENTER RENEWAL DATE   (MM/YY) :";MAG$(TT,2)
590 INPUT"HAVE YOU PAID FOR THIS SUBSCRIPTION";AN$
600 B$=LEFT$(AN$,1)
610 IF B$="Y" OR B$="N" GOTO 630
620 PRINT "PLEASE ANSWER YES OR NO":GOTO 590
630 IF B$="Y" THEN MAG$(TT,3)=B$:GOTO 660
640 INPUT"ENTER AMOUNT DUE :";DUE$
650 MAG$(TT,3)=DUE$
660 GOTO 110
665 '****** DELETE SUBSCRIPTION FROM FILE ******

670 CLS:PRINT:PRINT
680 INPUT"ENTER NAME OF MAGAZINE TO BE REMOVED FROM FILE :";N$
690 FOR R=1 TO TT
700 IF MAG$(R,1)=N$ GOTO 760
710 NEXT R
720 PRINT "NO MAGAZINE BY THAT TITLE FOUND"
730 PRINT "PRESS ANY KEY TO RETURN TO MENU"
740 IF INKEY$="" GOTO 740
750 GOTO 110
760 IF R=TT GOTO 800
770 MAG$(R,1)=MAG$(TT,1)
780 MAG$(R,2)=MAG$(TT,2)
790 MAG$(R,3)=MAG$(TT,3)
800 MAG$(TT,1)=""
810 MAG$(TT,2)=""
820 MAG$(TT,3)=""
830 TT=TT-1
840 GOTO 110
845 '****** SAVE ENTRIES TO DISK FILE ******

850 OPEN "O",1,"MAGAZINE/FIL"
860 PRINT #1,TT
870 FOR ROW=1 TO TT
880 FOR COL=1 TO 3
890 PRINT #1,MAG$(ROW,COL);",";
900 NEXT COL,ROW
910 CLOSE 1
920 GOTO 110

925 '****** CHECK FOR EXPIRING SUBSCRIPTIONS ******

930 CLS:PRINT:PRINT
940 INPUT"ENTER CURRENT MONTH-YEAR (MM/YY)";DT$
950 MM=VAL(LEFT$(DT$,2)):YY=VAL(RIGHT$(DT$,2))
960 BM=(YY-80)*12+MM
970 PRINT " MAGAZINES THAT WILL EXPIRE WITHIN SIX MONTHS :"
980 FOR C=1 TO TT
990 M=VAL(LEFT$(MAG$(C,2),2)):Y=VAL(RIGHT$(MAG$(C,2),2))
1000 CM=(Y-80)*12+M
1010 DM=CM-BM
1020 IF DM<6 THEN PRINT MAG$(C,1);:PRINT TAB(30)MAG$(C,2);:PRINT TAB(45)MAG$(C,3)
1030 NEXT C
1040 PRINT
1050 PRINT "PRESS ANY KEY TO RETURN TO MENU "
1060 IF INKEY$="" GOTO 1060
1070 GOTO 110
1080 CLS:PRINT
1085 '****** PRINT ENTIRE FILE TO SCREEN ******

1090 CU=1
1100 FOR N=1 TO TT
1110 PRINT MAG$(N,1);:PRINT TAB(30)MAG$(N,2);:PRINT TAB(45)MAG$(N,3)
1120 IF CU/10=INT(CU/10) GOSUB 1190
1130 CU=CU+1
1140 NEXT N
1150 PRINT
1160 PRINT "HIT ANY KEY TO RETURN TO MENU"
1170 IF INKEY$="" GOTO 1170
1180 GOTO 110
1190 PRINT "HIT ANY KEY TO SEE REST OF LIST"
1200 IF INKEY$="" GOTO 1200
1210 CLS
1220 PRINT
1230 RETURN
```

and then two nested loops, similar to those used to input the data at the start, file the rest of the data.

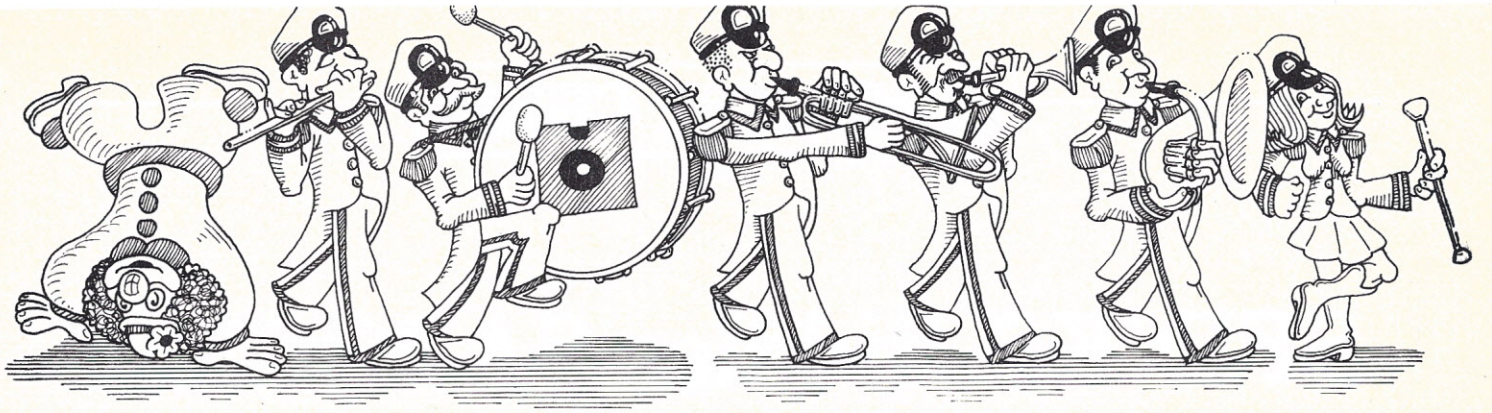
A check for subscriptions expiring withing six months of the current date can be made in lines 930-1080. This routine simply converts the current date into a months-elapsed since January, 1980, figure, and subtracts that number from the month-elapsed conversion of each subscription expiration date. For example, if the current date is April 1981, it would be assigned the value 15, and any subscriptions expiring earlier than month 21 (October 1981) would be listed to the screen.

The current month, input as *MM/YY,* that is 06/81 or 6/81, is parsed in line 950. Because the program takes the VAL of LEFT$(DT$,2), the correct figure is derived regardless of whether you input months earlier than October with or without a leading zero.

The months-elapsed figure is calculated in line 960, and a similar operation takes place for each magazine subscription in the file at lines 990-1000. The difference in the two figures is determined in line 1010. If less than six months remain for the expiration, a magazine is listed to the screen in line 1020.

The entire file can be listed to the CRT in the final module of Subscription List. A counter, CU, is used to determine when 10 items are shown on the screen. If CU can be divided evenly by 10 (line 1120), control branches to a ''page'' routine at line 1190. The divisor in line 1120 can be increased or decreased, depending on how many lines you want displayed.

I tried to make this program transferable to other BASICs. In all cases the KEY$ feature can be replaced by simple INPUT statements. Additional enhancements might include various ''weighting'' schemes that allow you to input a magazine title that is close, but not exactly the same, as the one in your file. In another instance, some of you may want different ways of retrieving data. For example, persons with long reading lists might want to search for all subscriptions costing more than $20 a year in order to pare down the expensive magazines to only those worth the price. Or, as another example, you may wish to find subscriptions that have been renewed but not paid.



Basic Marches On

BY DAVID LUBAR

Extensions, revisions, modifications — Basic seems truly dynamic. This month, we will cover some of the new commands that will be appearing in future versions of Basic. Note: This information was obtained by stealing the contents of the wastebaskets at several major software houses.

Following are the most exciting of the new comments:

APT — Similar to HOME, except that the cursor moves to a rented spot.

END RUN — Stops the computer un less there is a safety blitz.

THRUST — Used in the form THRUST X,Y where X is a memory location and Y is an ASCII character code. THRUST X,Y places the desired character in that location for eve and ever unless it is countered with a PRY X,Y command.

HIMOM — Lets her know you're thinking of her.

'LOMOM — See HIMOM.

DTAB — Diagonal TAB.

DIETTAB — Saves calories.

CHARGETAB — Allows the TAB to be deferred until the end of the month when the user will be billed.

Mr. Lubar's previous articles include "Software Update" (July 1980 PC*) and "How To Save Memory, Time and Your Fingers" (August 1980* PC*).*

DEL! — Goes through a program and deletes all exclamation points. This should be one of the most useful commands in future versions of Basic.

PIP — This moves the order of execution to the nearest subroutine. If there is no subroutine, nothing happens.

GAZE — Used in the form GAZE: X where X is a memory location. This command makes the computer take a good, long look at whatever is in that location, pausing to admire the beauty of it all.

GOFROM — Example: 200 GOFROM 200 will cause the computer to move somewhere else, adding excitement an unpredictability to humdrum programs.

ANDORIF — Gives anything the value of 1.

OR ELSE — Used in the direct mode to threaten an uncooperative computer. For example, LOAD OR ELSE.

BUS — Rearranges memory locations in desegregated order.

DIM — Not to be confused with DIM(X), this command drains current, dimming the lights in a room. No DAC required.

USSR — This machine-language subroutine translates a program into Russian. Reconversion is achieved using USA.

REAM — Allows up to 500 pages of REMarks.

**UP$** — Prints the upper half of a string in a 5×4 matrix. For example, 10 X$="HELLO": PRINT UP$(X$,1,3) will produce a result of "HEL"

DOWN — Similar to UP$.

MUD$ — Randomly reorder the elements of a string.

MOMPOPSTORE — Saves data on Sundays and late at night when you can't get access to regularSTORES.

DISCOUNTSTORE — Reduces the overhead in a SAVE, though there might be a slight drop in the quality of the data.

TOTALRECALL — Tells the computer not to bother saving anything since the programmer is sure he will remember everything.

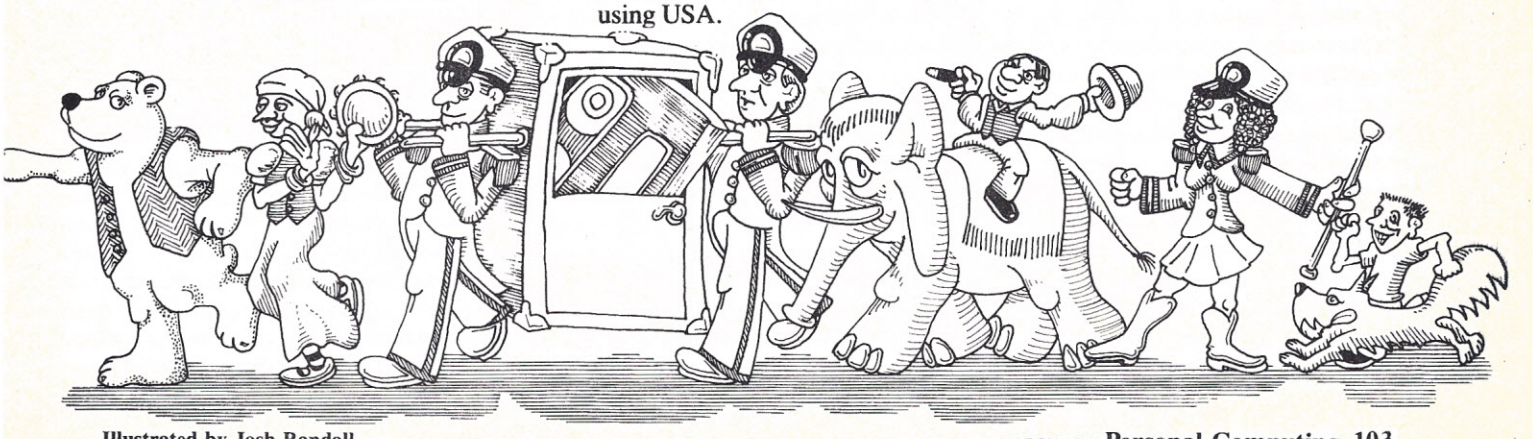
BOMB — Lets you do it first, beating the computer at its own game.

CREDIT — Automatically prints the programmer's name on the screen before the execution of any line.

NOT RACE — Not be confused with NO TRACE, this command slows operation, making sure that nothing is missed.

SAVOR — Puts a program on tape, then pauses to appreciate the beauty of the program.

GIT — Takes an input, goes away, and doesn't return.



Illustrated by Josh Randall

SFINKS Riddles SARGON II

BY WILLIAM A. FINK

This past week an acquaintance of mine from the Pompano Chess Club dropped by with a chess playing friend of his, a TRS-80 microcomputer! We had decided to match the TRS-80 version of *SARGON II* against my chess program *SFINKS*.

SARGON II hardly needs an introduction. Most of us recall *SARGON's* third place finish at the 9th North American Computer Chess Championship. The program has seven levels of play (0-6), and its choice of moves is based on an iterative tree searching algorithm.

SFINKS, on the other hand, is practically unknown. It finished as the first placed non-commercial entry at the First United Microcomputer Chess Championship this past fall. Like *SARGON*, *SFINKS* has seven levels of play (1-7) and its choice of moves is based on an iterative tree search.

Although the two programs are similar in these two respects, they were not easily matched. *SARGON*'s response times are based on the time needed to evaluate a fixed number of nodes. As a result, *SARGON*'s response times are consistent, but its depth of search varies with the number of pieces left on the board. *SFINKS*'s response times are based on the time needed to complete a search of a fixed depth (e.g., 4 ply); consequently, response times decrease as the number of pieces on the board decreases, so it was difficult to match the two games.

We settled upon playing the two games on levels which best approximated tournament-like response times. *SARGON II* was set on level three, and *SFINKS* was set on level four.

A four-game match was played. The results: *SFINKS* won two games, drew one and lost one. In all four games, *SARGON* spent less time than *SFINKS* in the middle game but more time in the end game. As one might guess, *SFINKS* reached won positions in all four middle games. The game *SFINKS* lost was lost in a king and pawn endgame. The drawn game was adjudicated a draw on move 60; *SFINKS* was up the exchange but had no idea of how to win the game while *SARGON II* was apparently playing for the draw by repeating moves. The third game of the match was selected for annotation because of the convincing manner with which *SFINKS* disposed of the veteran chess player, *SARGON II*.

Third Game

White: *SFINKS*	Black: *SARGON II*
1. e2-e4	**e7-e5**
2. c2-c4	**b8-c6**
3. g1-f3	**f8-c5**
4. d2-d3	**g8-f6**
5. f1-e2	**d7-d6**
6. e1-g1	**e8-g4**

Nothing is spectacular about *SFINKS*'s opening play. The pawn formation is unusual but solid. It is interesting that in closed positions the programs usually search deeper or respond faster. This is because there are fewer legal moves for each side to consider.

7. c1-d2	**g4-f3**
8. e2-f3	**e8-g8**
9. b1-c3	**d8-e7**

With this move, *SARGON* gets itself into trouble from which it never escapes.

10. d2-g5 . . .

SFINKS correctly exploits *SARGON II*'s last move. The threat is a c3-d5.

10. . . . c7-c6

No obvious threats are overlooked when the move selection process is based on a full-width search, as *SARGON*'s is.

11. c3-d5 . . .

SFINKS now has two threats: d5-c7 or g5-f6 followed by f3-g4.

11. . . . f6-e8

f6-d5 loses a pawn, but it may have been the best line. The move played permits f3-g4 which, theoretically at least, wins a pawn or more.

12. g5-d2 . . .

SFINKS riddles no one but the programmer whith this move! f3-g4 requires a five-ply search to be appreciated.

12. . . . e6-g6

This move adds fuel to the fire. Now *SFINKS* can play a kingside attack with f3-g4 or push the queen knight pawn with the ultimate threat of d5-e7 forking the black king and queen. Actually, it is impossible by today's standards for either program to foresee all these

possibilites in their allotted time, but, as we shall see, general heuristics are sometimes enough to direct the programs along on a good line of play.

13. f3-g4 . . .

SFINKS threatens to win the misplaced black queen. *SARGON* should play f7-f5 here. Rather than losing a pawn immediately though, *SARGON* sees it can go for three half moves without the loss of anything (e8-f6; g4-f5; g6-h5)! This is known as the horizon effect.

13. . . . e8-f6
14. g4-f5 c5-f2

Now *SARGON* sees the fault with the last move's analysis, but its reasoning remains the same. Rather than lose a queen for a bishop immediately, why not lose a bishop for a pawn?

15. f1-f2 f6-d5

SARGON can no longer push the loss of the queen over the horizon. The knight capture is good because it preserves the king's pawn protection.

16. f5-g6 d5-f6
17. g6-h5 . . .

Does *SFINKS* see the variation f2-f6, g7-f6; d2-h6, rook moves; d1-g4 check, followed by mate? This is a chess programmer's dream!

17. . . . a8-d8
18. f2-f6! . . .

A dream come true? This is really a sham sacrifice to remove the pawn from in front of the enemy king.

18. . . . g7-f6
19. d2-h6 c6-e7

Avoids mate. Better than g8-h8.

20. d1-f3 f6-f5
21. h6-f8 . . .

Typical of these computers, they take the material when they can get it . . .

21. . . . e8-f8
22. e4-f5 f8-b8

and save it when they can.

23. g1-h1

This kind of move makes a human chess player sit back and scratch his head. *SFINKS* considered it important here to remove the king from the semi-open file.

23. . . . b7-b6

This move was not played last time because it would have permitted the queen to play to b7 and win a pawn anyhow.

24. a1-e1 a7-a6
25. f5-f6 e7-g6
26. f3-e6 . . .

SFINKS is not forgetting about the kingside attack. It never knew it had one going. (It's difficult to convey concepts such as "kingside attack" to computers.)

26. . . . b8-f8

Preparing to fork the bishop and queen's pawn with the knight after the queen takes on e7.

27. g2-g3 f8-c8
28. c6-b7 e8-c8
29. b7-c7 e8-e6

This loses the rook! How can it be forseen? *SFINKS* forsees the win of the exchange only.

30. c7-d8 g6-f8
31. h5-g4 b6-b5
32. g4-e6 b5-c4

SARGON sees that if it captures the bishop, it will be mated in two moves.

33. e6-c4 a6-a5
34. d8-a5 f8-d7
35. a5-d5 . . .

SFINKS is indirectly protecting its pawn on f6 and threatening to win one of black's pawns. The mate is still a half-move beyond the horizon.

35. . . . d7-b6

SARGON now knows the end is at hand.

36. d5-f7 g8-h8
37. f7-e8 mate

Total time consumed by *SARGON II* in this game was 1 hour and 28 minutes. The total time consumed by *SFINKS* was 1 hour and 33 minutes. Both programs were running on TRS-80 microcomputers with clock speeds of 1.77 MHz.

Belle Wins Championship

BY D. LEVY, B. MITTMAN AND M. NEWBORN

A new world champion was crowned in Linz, Austria, at the 3rd World Computer Chess Championship.

Belle, written (and built) by Kenneth Thompson and Joseph Condon of Bell Telephone Labs in Murray Hill, NJ, won the tournament in an exciting playoff game against Chaos on the fifth day of the tournament. Belle was run on a newly constructed chess machine tied to a DEC LSI-11 at Bell Labs. Chaos of the University of Michigan, written by Fred Swartz, Mike Alexander, Jack O'Keefe and Victor Berman, was run on an Amdahl 470 in Sunnyvale, CA. Third place went to Duchess of Duke University, written by Tom Truscott, Bruce Wright and Eric Jensen competing on an Amdahl located at the Triangle Universities Computing Center in North Carolina.

As can be seen from the results, and from the game description that follows,there were some surprises and a good deal of excellent chess. The two former world champions, Chess 4.9 of Northwestern University in Evanston, IL (Toronto, 1977), and Kaissa of the Institute for System Science in Moscow (Stockholm, 1974), won only 2½ and 2 points, respectively. Other features of the tournament were the fine play shown by several microcomputers and the introduction of special purpose chess hardware.

Support for the tournament was

provided by the city of Linz after it became clear that insufficient funds would be made available to hold the tournament in Melbourne, Australia as originally planned. The championship, held as part of Linz's annual Bruckner Festival, was presented as one of the special events in the Ars Electronica activities which included seminars on electronics and the arts, computer music and a microcomputer chess exhibition. In keeping with the Ars Electronica theme, the Linz organizers had a unique first prize designed and built by their college for artistic and industrial design. We quote from the presentation document:

> The prize consists of an aluminum cube, its top surface made up of a three-dimensional chess board of 64 movable aluminum blocks, forming a unique relief-like arrangement.
>
> The interior of the cube houses an electronic control system causing the individual blocks to move up and down. This computer chess prize is intended to symbolize the tremendous possibilities of the game as well as those of the computer. It is programmed so as not to repeat any single pattern during the coming 1.169 trillion years, provided the apparatus doesn't stop working before reaching that age.

The tournament organizers were David Levy, Benjamin Mittman and Monroe Newborn. Commentary was done in German and English by German Grandmaster Dr. Helmut Pfleger. Local arrangements were organized by Dr. Ernst Kubin of the Linz Office of Special Events (LIVA).

Sunny afternoons found the programmers sipping Austrian white wine and analyzing and reanalyzing their games on the Tourotel terrace next to the Brucknerhaus overlooking the Danube. Two special guests had been invited to the tournament—Dr. Claude Shannon, the developer of information theory, and Mr. Fridrik Olafsson, president of the International Chess Federation.

Dr. Shannon, who published a landmark article entitled, "Programming a Computer To Play Chess," 30 years ago, stated in an interview that although tremendous progress has been made in those 30 years, the world chess champion has nothing to fear from computers for many more years to come. Mr. Olafsson, a grandmaster, had no problem in defeating Chess 4.9 in two blitz games. Nevertheless, he felt that computer chess had a great deal to offer in attracting world attention to the game.

The Play

Surprises began immediately in the first round when the reigning world champion, Chess 4.9, was defeated by L' Excentrique (written by Claude Jarry) running on an Amdahl V/7 at McGill University. Jarry, a former student of Newborn at McGill, saw his program generate considerable pressure by creating an early passed pawn. After this initial advantage, L' Excentrique began to play passively, allowing Chess 4.9 to recover and even pull ahead. (At one point Chess 4.9 calculated an evaluation of plus two pawns for its side.) L' Excentrique fought back after Chess 4.9 itself began to play passively, allowing a key bishop, which was protecting a queening square on the main diagonal, to be blocked. L' Excentrique queened, and Larry Atkin and David Cahlander resigned for the program. (Programs still do not resign themselves.) The tournament ended with both programs earning 2 1/2 points to tie for fourth place. In retrospect, L' Excentrique was stronger than most people thought it was, and Chess 4.9 was weaker than expected.

The second round saw Belle draw against Nuchess, a new entry by David Slate (one of the original authors of Chess 4.9) and William Blanchard of Northwestern University. The hard-fought game provided winning chances for both sides but ended in draw by repetition in an even position.

Duchess and Kaissa entered the third round with two points each. Kaissa played the white side of a Ruy Lopez opening and made a strategic error which allowed Duchess to infiltrate with a rook on the D-file. Kaissa's position became more and more passive and quickly collapsed. In the Nuchess-Chaos game in the third round, history repeated itself. Unexpectedly, Slate had not modified the openings library which he inherited from Chess 4.9 and found himself in essentially the same Queen's Gambit Accepted opening which was played against Chaos by Chess 4.0 in Stockholm in 1974. That game saw Chaos sacrifice a knight in what David Levy later described as the first computer chess game in which a program sacrificed material to gain a positional advantage. In Linz, the same sacrifice again led to an easy win for Chaos.

The fourth and final round of the Swiss-style tournament found Duchess with three points, needing only a draw to guarantee a finish no lower than a tie for first place. When Duchess met Belle, Duchess played an opening variation in which white sacrifices a pawn in return for some pressure. By failing to play sufficiently active, Duchess found "herself" down a pawn for nothing. After Belle picked up another pawn, there was no hope for white although the game dragged on for some time.

The championship was decided between Belle and Chaos in the most exciting game of the tournament. In an unusual variation of Alekhine's Defense, Chaos twice failed to find the most active move. (David Levy's annotations, which were prepared as the game progressed, are found in Figure 1.) Instead of reaching a position in which it would have had good chances, Chaos was soon a piece down without any real compensation. Belle's king found itself stuck in the center and was subjected to a few harassing checks. By careful parrying of black's simple threats, however, Belle insured that the result was never in doubt and it ended the game decisively with an announced mate at move 34.

Special purpose chess hardware permitted Belle to examine about 160,000 chess positions per second. This immense brute force search capability represents the best of today's level of play by a chess computer. Even so, most observers, including Ken Thompson, feel that brute force alone is insufficient to play at the grand master level.

By winning the tournament, Belle has earned the right to participate with Chaos in the two 1981 incentive competitions of the Fredkin prize. The Fredkin Foundation of Massachusetts has established a prize of $100,000 to the first program to defeat the world chess champion in an official contest. Before a serious threat by a computer can become feasible, Dr. Hans Berliner of Carnegie-Mellon University and a committee of trustees of the Fredkin prize will be organizing a series of incentive competitions matching the best programs in the world against human players with comparable chess ratings to these programs. The first such competition saw Chess 4.9 split two games with Paul Benjamin, a player with a low expert rating.

Other programs appeared with special chess hardware and microcomputers. Bebe and Advance 1.0, as well as Belle, use specialized circuitry for such functions as move generation, positional evaluation, or transpositions table management to speed up analysis. Among the microcomputer participants were Mychess and CSC. Even the last-place finisher played at a level which would have been respectable three years ago in Toronto. The microcomputers at the tournament participated in a speed-chess competition against six Austrian chess players. Mychess was impressive in winning five of its six games.

Figure 1-Playoff Game

Notes written by David Levy while the game was in progress.

White: Belle	Black: Chaos
1 e2-24	**Ng8-f6**
2 e4-e5	**Nf6-d5**
3 d2-d4	**d7-d6**
4 Ng1-f3	**d6xe5**
5 Nf3xe5	**g7-g6**
6 g2-g3	

More usual is 6 Bf1-c4. The text move is rarely played and now Chaos was out of its openings book.

6	**Bc8-f5**
7 c2-c4	

Black must be careful. If 7.....Bf5-e4?, white wins a piece with 8 f2-f3, while if 7.....Nd5-b4? 8 Qd1-a4+ Nb8-c6 9 Ne5xc6 Nb4xc6 10 d4-d5, again winning a piece.

7	**Nd5-b4?**

Having written the above note, I was naturally taken aback when Chaos played this move. What had I overlooked?

8 Qd1-a4+	**Nb4-c6**

Chaos had probably been under the same illusion as I, but in fact, it *could* have played 8.....Nb8-c6 quite safely, as 9 Ne5xc6 Nb4xc6 10 d4-d5 can be met by 10.....Bf5-d7 11 d5xc6 Bd7xc6, forking white's queen and rook.

Another possibility after 8.....Nb8-c6 is 9 d4-d5 Bf5-c2!, when 10 b2-b3 Bf8-g7 11 Bc1-b2 can be met by 11.....0-0, and if 12 d5xc6?? Qd8-d1 is mate! White may also try 10 Qa4-b5, but then 10.....a7-a6 11 Qb5xb7 Nc6xe5 12 Qb7xb4 Ne5-f3+ 13 Ke1-e2 Nf3-d4+ gives black good play for the pawn.

The conclusion is the black's seventh move is probably playable.

9 d4-d5	**Bf5-c2**
10 Qa4-b5	**Qd8-d6?**

In view of black's difficulties, it would have been better to try 10.....a7-a6 11 Qb5xb7 Nc6xe5 12 Qb7xa8 Ne5-f3+ 13 Ke1-e2 Nf3-d4+, when it is not clear who stands better.

11 Ne5xc6	**Nb8xc6**

And here black could try 11.....b7xc6 12 Qb5-b7 Qd6-e5+ 13 Ke1-d2 Bc2-f5.

The complications following 14 Qb7xa8 Bf8-h6+ are extremely unclear.

12 Nb1-c3	

White cannot yet capture on c6 because of mate on d1.

12	**Bf8-g7**
13 Qb5xb7	**0-0**
14 Qb7xc6	**Qd6-b4**
15 Ke1-d2	**Bc2-e4**
16 Rh1-g1	**Rf8-b8**
17 Bf1-h3	**Bg7-h6+**
18 f2-f4	

Black's threats have now been repulsed and white can play to consolidate its material advantage.

18	**Qb4-a5**
19 Rg1-e1	**f7-f5**
20 Qc6-e6+	**Kg8-f8**
21 b2-b3	**Bh6-g7**
22 Bc1-b2	**Bg7-d4**
23 g3-g4	**Rb8-b6**
24 Qe6-d7	**Rb6-d6**
25 Qd7-a4	**Qa5-b6**

Black's only hope is to keep the queens on and play for an attack against the white king.

26 Bb2-a3	**Bd4xc3+**
27 Kd2xc3	**Rd6-d8**
28 Ra1-d1	**Qb6-f2**

Although white is a piece ahead, its task is not easy. The exposed king gives rise to all sorts of tactical possibilities.

29 g4xf5	**Qf2-c2+**
30 Kc3-d4	**g6xf5**
31 Qa4-c6	**Qc2-f2+**
32 Kd4-e5	**Kf8-g8**
33 Re1-g1+	

Black's king now comes under attack.

33	**Kg8-h8**
34 Ba3xe7	

With this move, Belle announced it had found a forced mate. The threat is 35 Be7-f6 or 35 Qc6-f6.

34	**Qf2-g2**
35 Qc6-f6+	**Kh8-g8**
36 Bh3xg2	**Rd8xd5+**
37 Ke5-e6	**h7-h6**
38 Qf6xh6	**Rd5-e5+**
39 f4xe5	**Ra8-f8**
40 Bg2-f3 mate	

WHAT'S COMING UP

SOFTWARE

Time and Billing System for the Legal Profession

Lifeboat Associates distributes a time and billing system for the legal profession. The system operates with most microcomputers under Digital Research's CP/M operating system.

ESQ-1 is an integrated information system specifically written with the first time computer user in mind. It is functionally separated into several distinct modules for transaction entry (time incurred and disbursements), posting, file maintenance and inquiry, billing, receipts, reports, end of day backup, end of period updating and client analysis.

ESQ-1 records billable and non-billable time, cash receipts and escrow receipts, and escrow transfers. Inquiries into all files can be made with numerous criteria such as by client/matter, responsible attorney, invoice number, etc. The system provides complete billing and payment ledgers and optionally allows the user to apply receipts to the oldest invoices first or to specific invoices. The program will print on continuous forms or single sheet letterhead paper. Some of the reports included are pre-billing worksheet, detailed ageing of accounts receivable by client/matter or billing attorney, attorney productivity, mailing labels, etc.

ESQ-1 requires a 48K CP/M system, CBASIC-2, two disk drives with 220K bytes per drive, a CRT terminal with direct cursor addressing, and a 132-column printer. The complete system and documentation including a 45 minute cassette training tape is available for $1500 from Lifeboat Associates, 1651 Third Avenue, New York, NY 10028; (212) 860-0300. Documentation alone is available for $50. A complete demonstration system from ESQ-1 is available for $75. *Circle No. 101*

Assembler ROM from Hewlett-Packard

A marketing effort designed to sell non-HP software for HP Series 80 personal computers, and an assembly-language read-only-memory module, designed to ease Series 80 software development, have been announced by Hewlett-Packard.

Under the Software Supplier Program, Hewlett-Packard will help promote software developed by other firms for Series 80 machines. HP will make the software easy to order by putting a catalog of all Series 80 software in the hands of all HP personal computer dealers and sales offices.

The Series 80 Assembler ROM lets software developers write assembly-language programs. It gives the developer access to hundreds of routines in the operating system, increases speed in some applications, and makes it possible to create new BASIC commands and functions.

The ROM gives developers entry points into hundreds of routines in the BASIC operating system, including all math routines, high- and low-level CRT control, general I/O routines, and many other utility routines.

The assembly-language programs let you increase processing speed in some applications, create new BASIC commands and functions, redefine existing BASIC keywords, and expand I/O control. And source and object code can be stored on tape cartridge or disk.

Full documentation comes with the Assembler ROM in the form of a 400-page manual that makes all of the ROM's capabilities easily understandable.

The Series 80 Assembler ROM list price is $295. For more information contact Inquiries Manager, Hewlett-Packard Co., 1507 Page Mill Road, Palo Alto, CA 94304; (415) 857-3752. *Circle No. 117*

Program "Paints" Pictures in 21 Colors

Micro-Painter, employing high-resolution graphics to "paint" pictures in 21 different colors on the Apple II, has been released by Datasoft, Inc.

Designed for computer hobbyists and professional programmers, Micro-Painter includes a magnification feature for dot-by-dot coloring, and inverse coloring. Once painted, pictures can be saved or displayed in any combination of colors or in an unpainted state. Pictures can also be repainted at any time.

Micro-Painter is written in both BASIC and machine language for all Apple II computers. The program is available from stock for $34.95. For more information contact Datasoft, 16606 Schoenborn St., Sepulveda, CA 91343; (800) 423-5630; in CA, (213) 894-9154. *Circle No. 102*

Electronic Mail and Message System

Announcing that the office of the future is available today, Nestar Systems, Inc., inaugurates The Messenger, an easy-to-use interoffice electronic mail and message system.

Using the Nestar Cluster/One Model A local computer network (LCN), The Messenger allows anyone connected to the Apple-based system to eliminate the interoffice memo and the tyranny of telephone pink slips. The instantaneous delivery of messages by this computer-based electronic mail system is designed to save the scarcest of all managerial resources — time. A typical Messenger installation pays for itself in less than one year of normal use.

The Messenger features simple, easy-to-use commands that eliminate the need for special training. For example, the commands SEND, ANSWER and FORWARD give you all options necessary to communicate quickly and accurately with one or more persons on the system. The NEWS command enables such items as company bulletins, departmental announcements and operating information to reach key people by simulating an internal news service.

Incoming messages can be scanned quickly by sender or subject category, read and then deleted or filed for future reference. Copies of outgoing messages can also be filed automatically. Each message received may be classified by categories: up to 23 classes may be defined, and a message may be filed in one or more of those classes for the purpose of cross-referencing and quick access by subject. Other Messenger commands such as L (Last), F (first), C (current), N

(next) and P (previous) permit interactive electronic message reviews in the same manner as users would manually leaf through a pile of paper messages.

The Messenger integrates naturally into standard office procedures by providing facilities such as distribution and carbon-copy lists. Users can add their own comments to a message and forward it on to others for review, without having to rely on the office copier. The Messenger's Return Receipt feature goes beyond standard interoffice memo systems by automatically returning a Notification of Receipt to the sender when his message has been read.

The Messenger opens doors for you to use all the facilities, tools, software and languages available on an Apple II computer. Interfaced through Nestar's Cluster/One Model A file server utilities, users of The Messenger may edit messages, call in previously stored data files, print messages or prepare messages for remote-access via telecommunications devices such as modems. The full power of the Apple II's Pascal editor is also available as are any of the peripheral devices shared through the Cluster/One LCN.

The Messenger is a priced licensed program for the Cluster/One Model A, available by annual lease of $1,250 including central maintenance. The license fee is waived after the second year. A fully paid-up license is available for $2,250, including two years of central maintenance. The Messenger requires a Cluster/One Model A local computer network, supporting anywhere from 2 to 64 Apple Pascal stations. For more information contact Nestar Systems Incorporated, 430 Sherman Ave., Palo Alto, CA 94306; (415) 327-0125. *Circle No. 103*

One-on-One Basketball Game

Acorn Software Products, Inc. announces the debut of Basketball, a new one-on-one basketball game program.

Basketball is designed for the Model I Level II TRS-80. The program features a five-key player control range allowing defensive play backwards, defensive coverage and offensive maneuvers from side-to-side, offensive drives forward down court, and shooting/scoring capability at any time beyond the center line. Single player option offers five levels of difficulty.

Basketball is priced at $14.95 on cassette or $20.95 on diskette. For more information contact Acorn Software Products, Inc. 634 North Carolina Ave., S.E. Washington, DC 20033; (202) 544-4259. *Circle No. 104*

Income Property Analysis

E-Z Software announces the release of INCOPROP, a computer program which makes the time-consuming task of traditional income property analysis obsolete. According to the company, INCOPROP appeals to real estate brokers, sales people, counselors, educators, students and investors.

The program is based upon standardized methods of pro-

perty analysis used throughout the real estate industry. The analysis generates a property operating statement and a 10 year cash flow analysis. Both of these detailed statements are compatible with similar forms provided brokers by the National Association of Realtors. High accuracy of an investor's projected after-tax income stream is assured by the use of a built-in I.R.S. tax table. According to the company, the easy-to-use program requires no special skills in either programming or income property analysis. INCOPROP is written for the Radio Shack TRS-80 Model I or the new Model III.

Sold on cassette for easy transfer to disk, the program comes with a comprehensive 78-page user's manual and a pad of data worksheets all in a 3-ring binder for $120. For more information contact E-Z Software, P.O. Box 591, Novato, CA 94947; (415) 388-0238. *Circle No. 105*

Data Management Utility

Micro Data Base Systems offers a new utility for use with the firm's hierarchical data base management system (HDBS). The utility, called the Schema Redesign System (HDBS.SRS), allows you to modify elements of an existing data base structure.

The system permits you to add new fields, expand the size of the data base, and rename fields, records and sets. Redesign is performed dynamically, doing away with the chores of off-loading the data base, changing the structure and then reloading the data base.

A related product, the Dynamic Restructuring System (or MDBS. DRS), performs similar functions for a full, network data base system (MDBS). In addition, DRS lets you add new passwords, records tapes and set types, to have new owners and members inserted into a set, and to alter existing access links. Passwords, fields, records, owner and member records, and whole sets can be deleted from the schema.

SRS and DRS are available for most of the operating systems and languages with which HDBS and MDBS are interfaced. SRS is priced at $150 (US and Canada) and DRS costs $300 (US and Canada). For more information contact Micro Data Base Systems, Inc., PO Box 248, Lafayette, IN 47902; (317) 448-1616. *Circle No. 106*

Accounts Receivable for TRS-80 Model II

An Accounts Receivable System designed exclusively for use as a Balance Forward System has been announced by Taranto & Associates, Inc.

This system is not invoice oriented. Each transaction is a separate item and not related to any other. Transactions are discarded at the end of the month.

The system features full recurring transaction facility, with no need to re-enter regular periodic charges. The Balance Forward system is a high speed, high volume system, capable of handling up to 2000 customers and 11,000 monthly transactions. The system produces aged statements

and features a full service charge facility. A useful inclusion is the mailing and shipping label program, which can print labels in zip code sequence and offers range selection capability.

The Balance Forward Accounts Receivable System is ideal for credit cards, retail stores, country clubs, churches and so forth. Price is $399 including a 72 page manual. For more information contact Taranto & Associates, Inc., P.O. Box 6073, 121B Paul Dr., San Rafael, CA 94903; (415) 472-2670. *Circle No. 118*

Computer News for the Accountant

Dataword Corporation has developed a new, comprehensive client write-up system that will put computer technology within financial grasp of even the smallest of accounting firms.

According to the company the versatile new system, called Datawrite, is the accountant's entry into the world of computers at a fraction of the cost of larger minicomputer systems. Datawrite will operate on CP/M compatible microcomputers from over fifty manufacturers. It is designed for either floppy or multi-user hard disks, and combines all the quality and features of the more expensive systems.

Datawrite incorporates advanced operator entry routines, expanded account number structure, several journal options and complete report writer capability, allowing an accountant to format any client statement desired.

Price is $2995. For more information contact Dataword, Inc., 1404 140th Place N.E., Bellevue, Washington, 98007; (206) 643-2050. *Circle No. 107*

Self-paced Learning Packages

CompuCourse programs are self-paced learning packages consisting of microcomputer software and printed self-study materials which address business and general interest areas.

Improving Memory Skills, helps you organize thoughts and accomplish tasks in half the time.

An accompanying self-study text teaches how to read effectively and retain more; remember what is heard and seen; use a sensory approach to memory; utilize memory aids like mnemonics and the key-word alphabet; put phone numbers on tap for instant recall; and memorize a speech or presentation in just minutes.

The "Micro-Applications" software (which runs on the Apple II with Extended Basic, and the Apple II Plus, with a single disk and 32 K of memory) gives practice in using the memory techniques which you learn in the text. The computer helps you select the best individually suited memory recall method by providing tests of memory retention rate, and instant plots of retention vs. time; computer-administered pre-testing, aid in learning each of several memorizing techniques, and computer-based monitoring and post-testing; and computer interplay to develop and improve reading

retention, learning of names, and memorizing of lists.

Personal Financial Planning, is a survival course for the 80s to help you plan for a more secure financial future in spite of today's shrinking dollar.

An accompanying 250-page self-study text guides the user in learning proven strategies and capital-building techniques, including how to create a personal balance sheet; develop income-producing spending plans; analyze purchases in terms of alternate consumption possibilities; evaluate investments; create a tax-minimizing estate plan; build a sound personal portfolio; and select compensation devices that put more after-tax dollars in one's pocket.

The course's financial planning methods are brought to life by the desktop computer through the "Micro-Applications" software provided with the course. The software (which runs on the Apple II with Extended Basic, and the Apple II Plus, with a single disk and 32 K of memory) turns the computer into an interactive planning system, allowing you to prepare a personal balance sheet for use in analyzing net worth; compile annual income and expense summaries for past years, using checkbook entries, charge slips, and cash receipts, and to prepare budgets for upcoming years; create automated systems for maintaining records of one's personal insurance; and assist in one's estate and retirement planning, including analysis of insurance, investment and retirement programs.

Planning Cash Flow, provides techniques for the management of working capital (including not only cash, but also short-term securities, receivables, inventory, payables, and short- and intermediate-term debt), and covers sources and uses of short-term funds. It also teaches timing of cash flows, how to turn inventory into cash, and how to manage money more efficiently.

An accompanying self-study text covers how to combine accounting and operating data to produce a comprehensive picture of present and expected cash flows; prepare an analysis showing how improved management of working capital can result in more opportunity for savings than changes in any other aspect of an organization; and maximize the utilization and minimize the cost of short-term credit. The software runs on the Apple II with Extended Basic, and on the Apple II Plus, requiring a disk drive and 32 K of memory. The component programs, called "Micro-Applications", help you to develop a cash requirement forecast for the coming year. You then learn how to maximize cash position by using your computer to perform an analysis of working capital, reviewing key factors such as liquidity ratios; analyze the effects of changes in the credit policy on profits and receivables; evaluate changes in and predetermine inventory requirements, including quantity and frequency optimization; and develop a complete cash flow plan to assist in determining financing requirements and cash surplus.

The prices of Planning Cash Flow, Improving Memory Skills and Personal Financial Planning are $99.95 each. The programs are available from local computer stores, and from Educational Programming Systems, Inc., 1328 Baur Blvd., St. Louis, MO 63132; (314) 991-0300.

Circle No. 108

Lower Case Adapter for New Apple

The original Dan Paymar Lower Case Adapter, the LCA-2, is available for the new Revision 7 Apple II computers (the new computers are easily identified by the absence of the RAM configuration blocks on the mother board). Nearly all popular text editors and word processors are compatible, and patches are available to make Applewriter and Pascal compatible with the LCA.

DICE (Dan's I/O Control Enhancements) support software is supplied on diskette for only $5 with your order ($10 if ordered separately), or may be copied at your dealer at nominal cost for support of the Dan Paymar LCA. DICE allows lower case keyboard input in BASIC without hardware modifications, and provides slow list, easy cursor positioning and other I/O enhancements.

The LCA-1 (for the Revision 6 and older Apple IIs) is $59.95 and the LCA-2 is $49.95. Both models are shipped from stock. For more information contact Dan Paymar, Enhanceware, 91 Pioneer Place, Durango, CA 81301;(303) 259-3589. *Circle No. 109*

PERIPHERALS

Nine-Voice Music Synthesizer for Apple

Peripherals Plus offers the ALF/Apple Music II (AM-II), a printed circuit board that plugs into an Apple II computer, plus software, that turns the Apple into a simple-to-use nine-voice music synthesizer.

Like the earlier ALF/Apple Music synthesizer, the AM-II allows you to compose music with two game paddles (instead of complicated keyboard commands), along with a graphic display of notes and the music staff. You can select notes on the staff (from a six octave range), and duration and many other characteristics from a menu at the bottom of the screen. During playback of the music, the music is shown on an animated, 16-color display.

Using the keyboard, you have control of tempo, key, duration, envelope values and duration, waveform and length. You can also edit or save a song, or create a music subroutine for use in another song or another program.

A 16K Apple II or Apple II Plus is required. The AM-II is available in cassette or disk versions for $198 from Peripherals Plus, 119 Maple Ave., Morristown, NJ 07960; (800) 631-8112. In New Jersey,(201) 267-4558. *Circle No. 110*

Interface Expansion Boards

The MDX-2 is a PC board allowing TRS-80 users to expand their systems as required. The board connects to the TRS-80 expansion connector and offers 32K memory expansion, a direct-connect 300 baud modem, an RS232 or 20ma loop serial port, an 8 bit parallel port, a single density floppy disk controller, a dual cassette line, real-time clock hardware

and a 2K or 4K EPROM. The required power supply is also on the board.

The phone modem is switchable for either answer or originate modes and is jumper selectable to the on-board serial port or any other 300 baud serial port. The serial port is switch selectable for both transmit and receive from 100 baud to 9600 baud. An RS232 connector is used for the connection.

The floppy disk controller and parallel port are both TRS-80 compatible, so any printer or floppy disk that runs on a TRS-80 will run on the MDX-2, the company said.

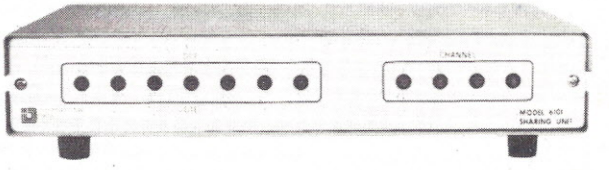
Each board comes with a comprehensive 50-page User's Manual including sections on the design overview, assembly, parts lists, circuit theory and data sheets. A serial driver program is included to drive the phone modem.

The boards come totally bare (no parts). Parts kits and assembled boards are also available. The prices are: MDX-2 PC board and manual, $74.95 plus shipping; MDX-1 PC board and manual, $64.95 plus shipping; MDX-1 or MDX-2 manuals, $5.95 plus shipping. For more information contact Micro-Design, P.O. Box 18054, Austin, TX 78760; (512) 458-2937. *Circle No. 111*

Sharing Unit Reduces Polling Network Costs

International Data Sciences introduced its new Model 6101 Sharing Unit, designed to allow varied combinations of up to four modems or data terminals to share a common communications device. Its use can simplify and/or expand a data communications system by decreasing the number of computer ports, modems and transmission lines required for existing and future operational requirements; thus also providing a significant hardware cost savings, the company said.

The IDS Model 6101 operates at data rates up to 19,200 bps in both synchronous and asynchronous modes. For synchronous operation, a common transmit timing signal can be derived from the common side interface, distributed channel or from the optional internal clock.



Features of the IDS unit include front panel LEDs that indicate the status of TD, RD, RTS, CTS, DCD, DSR and DTR on the common side; and monitor the activity of the four distributed channels. An RTS/CTS time delay is provided when the Sharing Unit interconnects a common data terminal to distributed data terminal equipment. This delay can be selected on a channel-by-channel basis for either 5, 50, 150 or 200 milliseconds.

Each channel incorporates an anti-streaming timer to pre-

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SALES OFFICES

- **Northeast:** Arlene Schulman Personal Computing Magazine, 2 Park Ave., New York, NY 10016; (212) 340-9780.
- **Southern California:** Michael Reynolds, Hayden Publishing, 8939 S. Sepulveda Blvd., Los Angeles, CA 90004; (213) 641-6544.
- **Northern California:** Bill Knickel, 1307 South Mary Ave., Suite 212 Sunnyvale, CA (408) 736-6667
- **Japan:** K. Yanigihara, International Business Corp., 10-10 Shinjuku 3-come, Shinjuku, Tokyo, 160 Japan: (03) 350-0272.

vent a distributed device from occupying excessive channel time. This timer can be either disabled or selected for 30-second or 5-minute durations.

Modems and data terminals can be collocated up to 50 feet from the IDS Sharing Unit. This allows a maximum separation up to 100 feet between common and distributed devices. The maximum separation can be extended to 500 feet using IDS low capacitance RS-232 cable.

The IDS Model 6101 Sharing Unit is priced at $650. Delivery is 30 days ARO. For more information contact Marketing Department, International Data Sciences, Inc., 7 Wellington Rd., Lincoln, RI 02865; (401) 333-6200.

Circle No. 112

COMPLEMENTS

Computer Guide for Small Businesses

A business computer guide for small companies has been published by Pertec Computer Corporation. The booklet, "The Small Business Owner's Guide to Small Business Computers", describes the advantages of owning a desk-top accounting and information system.

The pocket-size publication is an outline in everyday language of how a small business system operates, what it consist of and how it functions with printers and terminals, the company said. It also explains such computer concepts as memory, memory capacity and storage, as well as the financing and servicing of computer products.

A copy of the booklet is available free of charge from Pertec Computer Corporation, Dept. 200, P.O. Box 4095, Norht Hollywood, CA 91607.

Circle No. 113

1981 Radio Shack Catalog

Radio Shack's new 176-page 1981 catalog is now available free on request from more than 6000 participating stores and dealers nationwide.

The catalog has 120 full-color pages and features the latest in everything electronic from computers and stereo components to toys and electronic games, parts and accessories for home entertainment, hobbyists and experiments, the company said.

Among the products being offered for the first time are the TRS-80 Pocket Computer, the TRS-80 Color Computer and the TRS-80 Model III Desk Top Computer; six new stereo receivers, two digital quartz tuning; five stereo cassette tape decks featuring Dolby noise reduction circuitry.

Radio Shack has also expanded its line with the ad-

dition of 12 new telephone products including a cordless handset telephone. In the area of home security, Radio Shack will offer the latest in home alarm systems. One microprocessor-controlled system enables homeowners to protect all openings without any wiring required.

The new catalog includes the company's TRS-80 line of microcomputers, Realistic stereo components, CB equipment, radios, tape recorders, 13 new electronic calculators, six digital clocks, 17 electronic games, Archer antennas, Micronta test instruments and ArcherKit and Science Fair hobby kits.

In addition, Radio Shack's catalog lists an extensive selection of specialized electronics items, tools, tubes, transistors, ICs, parts, plugs and cables. For more information contact Radio Shack, 1800 One Tandy Center, Fort Worth, TX 76102;(817)390-3272.

Circle No. 114

Product Line Highlighted In New Brochure

An eight-page, two-color brochure is available from The Standard Register Company on its forms, forms handling and data systems. This source provides selections of products designed to meet specific paperwork systems requirements for gathering, organizing, storing and presenting data for action control.

The brochure illustrates and describes the various business forms manufactured by Standard Register from continuous forms to special constructions of continuous tab card forms, mailers and labels. The literature briefly lists the products that are used for small business computers and word processing supplies such as magnetic cards, tape cassettes and flexible disks, the company said.

Health care systems are also developed by Standard Register, and the brochure provides examples of x-ray envelopes, data terminals and software systems designed specially for this growing field, the company said.

In addition to business forms, the literature also describes the firm's line of forms handling equipment, from registers and handwritten, multicopy continuous forms to separators, imprinters and bursters, or a combination of all three.

The brochure also describes various data systems and services provided by Standard Register, to be used alone or with other existing systems. Some of these systems include the Source Record Punch (SRP), the Label Preparation System (LPS), the Prompt programming system for customized labels, and the 399 Patient Information Retrieval Systems (PIRS).

The full product line brochure is available, free, by writing to The Standard Register Company, P.O. Box 1167, Dayton, OH 45401. *Circle No. 120*

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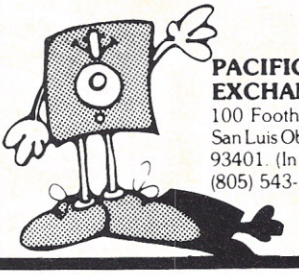

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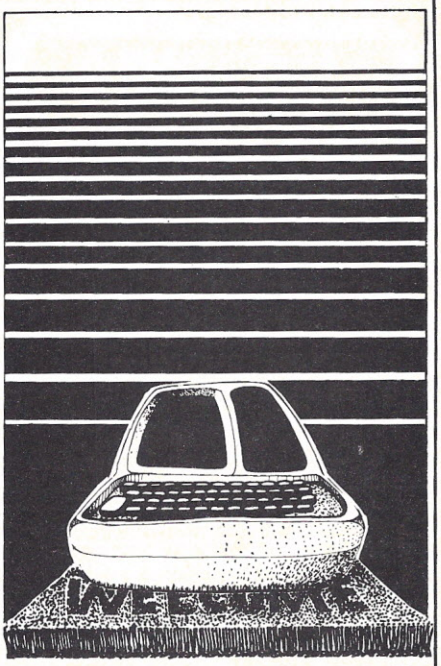

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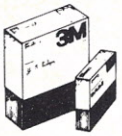

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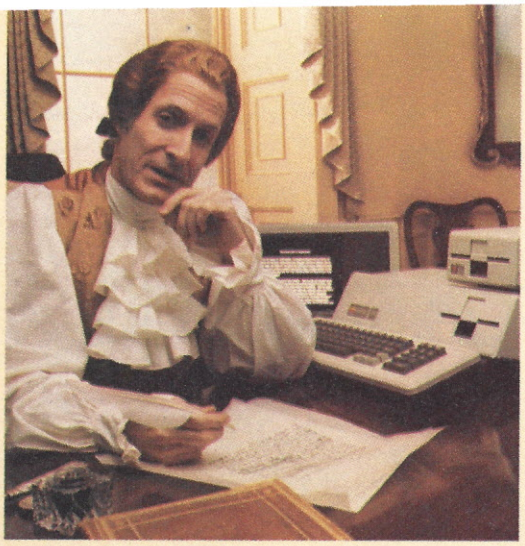

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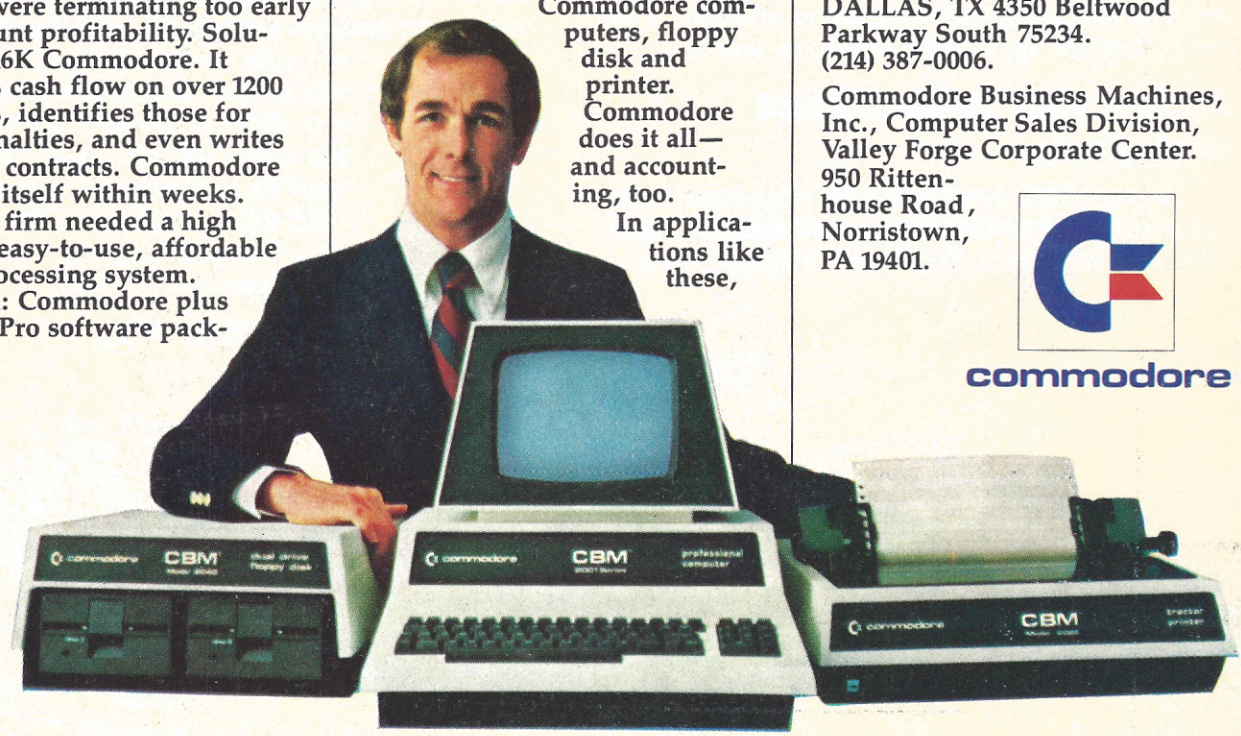

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